

PEARY CARIBOU STATUS REPORT





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by

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**The Committee on the Status of Endangered Wildlife in Canada
(COSEWIC)**

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This Peary caribou status report is a revised version of the update of the first status report on Peary caribou by the Canadian Wildlife Service to the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 1979 (Gunn, A.; Miller, F.L.; and Thomas, D.C. 1979) and a new evaluation of the current (1987) status of Peary caribou. I freely acknowledge the contributions made by other authors in the first Peary caribou status report. When statements from the original text remain currently accurate and pertinent, they have been incorporated either essentially as previously stated or revised to conform with my current thinking on the subject. Thus, I am solely responsible for any resultant errors of omission or commission. This Canadian Wildlife Service report is intended as an updated working document for use by COSEWIC in evaluating the current status of Peary caribou.

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A. Abstract

Peary caribou (*Rangifer tarandus pearyi*) populations on the Queen Elizabeth Islands of the Canadian High Arctic have suffered a continual overall drastic decline of about 90% in the past three decades. Their island-populations are now mere remnants of their former sizes and their future survival is endangered and in doubt. The Canadian Wildlife Service recommends that the Committee On the Status of Endangered Wildlife In Canada recognize the plight of the Peary caribou on the Queen Elizabeth Islands and reclassify them as an "Endangered" form of wildlife in Canada. This would be a beneficial first step in advancing the conservation and preservation of the Peary caribou.

The most biologically sound and necessary approach for the proper conservation of Peary caribou involves first the recognition of those populations of *R. t. pearyi* on the Queen Elizabeth Islands as genetically and possibly ecologically distinct from all other forms of *Rangifer*, including those forms of "arctic-island" caribou (*R. t. groenlandicus* $\times$ *pearyi*) on the southern tier of Arctic Islands. Polyacrylamide gel electrophoresis analyses of transferrin variation indicates that both kinds and frequencies of alleles present are significantly different between Peary caribou from the Queen Elizabeth Islands and "arctic-island" caribou from the southern tier of Arctic Islands (south of ca. 74°N).

Ancestral Peary caribou (*R. t. pearyi*) that originally occupied the southern tier of Arctic Islands were contaminated over time with genetic material from invading barren-ground caribou (*R. t. groenlandicus*) from the mainland and the caribou populations now found on those islands no longer represent the purest line of *pearyi*. All current and recent analyses of transferrin alleles (and also the precursory studies using morphometrical measurements, when examined in detail) substantiate the distinction between the *pearyi* line of Peary caribou on the Queen Elizabeth Islands and the transitional forms of "arctic-island" caribou (*groenlandicus* $\times$ *pearyi*) from the southern tier of Arctic Islands. Also, there is no evidence that barren-ground caribou from the mainland or even "arctic-island" caribou from the southern tier of Arctic Islands ever invaded and successfully established themselves on any of the Queen Elizabeth Islands. Therefore, it appears most likely that there are important stringent environmental differences between High Arctic range and more southerly ranges, including the southern tier of Arctic Islands, that demand first the evolution of physiological and morphological characteristics now possessed only by the purest line of *pearyi* in order to survive in the Canadian High Arctic over time.

Thus, the *pearyi* line on the Queen Elizabeth Islands is both genetically and ecologically diversified from the *groenlandicus* $\times$ *pearyi* forms now found on the southern tier of the Arctic Islands and cannot be considered interchangeable or the same in terms of their conservation or preservation. This distinction has par-

ticularly strong management implications as regards the feasibility of translocations of transitional forms of "arctic-island" caribou from the southern tier of Arctic Islands to the Queen Elizabeth Islands in the event of total die-offs. The existing evidence argues that such an option would not be biologically sound or viable.

The Peary caribou is the only member of the deer family Cervidae and the only form of *Rangifer* found in the Canadian High Arctic. The passing of Peary caribou from the terrestrial ecosystem of the Canadian High Arctic would represent a significant tragic loss of highly evolved genetic material and it would create both significant ecological and sociological voids in the natural heritage of the Canadian Arctic.

Rangifer tarandus pearyi is a uniquely Canadian subspecies now found regularly only on the Canadian Arctic Archipelago and nowhere else in the world. The total present number (3300-3600) of Peary caribou is a mere remnant of their former strength and their precarious existence in one of the harshest environments in the world is under potential pressure from anthropogenic climate change, hunting, disturbances from nonrenewable resource developments, and man-caused contamination of the arctic ecosystems. Thus, because of their perilous state and the potential for man's actions further detrimentally impacting on them, Peary caribou on the Queen Elizabeth Islands should be classified as "Endangered".

The trend in population estimates for "arctic-island" caribou on Banks Island has been one of decline since the early 1970s to only about 30% of the former size. As the currently estimated size of the caribou population will not sustain even the current (1989) reported level of harvest let alone higher past rates of harvest, the population of "arctic-island" caribou on Banks Island should also be classified as "Endangered".

The single population estimate for caribou on Victoria Island in 1980 must be a gross underestimate of the subsequent size of the population, if the reported annual harvests in the 1980s are accurate. It would require about three times as many caribou as estimated on Victoria Island in 1980 to sustain the population under subsequently reported rates of annual harvest. Otherwise, the potential for rapid decline of the "arctic-island" caribou on Victoria Island is real, especially if compounded by high mortality or failures of calf crops due to other factors. The information available for "arctic-island" caribou in the Prince of Wales Island-Somerset Island-Boothia Peninsula complex is inadequate to ascertain their current numerical status. If, however, the population size has declined or the annual harvests have increased greatly, the potential is for future population decline on that island-peninsula complex. Thus, those populations of "arctic-island" caribou on Victoria Island and the Prince of Wales Island-Somerset Island-

Boothia Peninsula complex should be classified as "Threatened" until their vulnerability to increased hunting pressures and man's actions are assessed or the population obviously fails.

Caribou on King William, Royal Geographical Society, Matty, and Jenny Lind islands are currently too few to be meaningfully evaluated separately and they should be grouped with the other "arctic-island" caribou recommended for the "Threatened" status.

A. Résumé

Les populations de caribous de Peary (*Rangifer tarandus pearyi*) des îles de la Reine-Élisabeth, dans le Grand Nord canadien, ont diminué dans des proportions catastrophiques au cours des trois dernières décennies, leur nombre ayant chuté d'environ 90 %. Les populations insulaires ne sont plus maintenant qu'un vestige des troupeaux d'antan, et leur survie est précaire et menacée. Le Service canadien de la faune recommande que le Comité sur le statut des espèces menacées de disparition au Canada reconnaisse la situation critique dans laquelle se trouvent les caribous de Peary des îles de la Reine-Élisabeth et qu'il les reclasse comme étant une espèce "menacée de disparition" au Canada. Cette action constituerait une première étape favorable en vue d'aider à la protection et à la conservation des caribous de Peary.

L'approche la plus sensée et la plus essentielle au point de vue biologique pour la conservation adéquate des caribous de Peary implique tout d'abord que les populations de *R. t. pearyi* des îles de la Reine-Élisabeth soient reconnues comme étant génétiquement et peut-être écologiquement distinctes de toute autre forme de *Rangifer*, y compris les espèces de caribou "des îles arctiques" (*R. t. groenlandicus* x *pearyi*) qui se trouvent dans la partie sud de l'archipel arctique. Des analyses avec électrophorèse en gel de polyacrylamide des variations de transferrine ont indiqué que les allèles du caribou de Peary des îles de la Reine-Élisabeth et ceux du caribou "des îles arctiques" de la partie sud de l'archipel arctique (sud du 74^e parallèle nord) présentent des différences importantes en ce qui a trait à leur nature et à leur fréquence.

L'ancêtre du caribou de Peary (*R. t. pearyi*) qui occupait auparavant la partie sud de l'archipel arctique a fini par être contaminé par du matériel génétique provenant du caribou de la toundra (*R. t. groenlandicus*) qui avait envahi son territoire à partir du continent. Ainsi, les populations de caribous qu'on trouve maintenant sur ces îles ne représentent plus la lignée la plus pure de *pearyi*. Toutes les analyses courantes et récentes des allèles de transferrine (de même que les études préliminaires effectuées à l'aide de mesures morphométrique lorsqu'on les examine en détail) justifient la distinction établie entre la lignée *pearyi* du caribou de Peary des îles de la Reine-Élisabeth et les formes transitoires du caribou "des îles arctiques" (*groenlandicus* x *pearyi*) de la partie sud de l'archipel arctique. De plus, rien n'indique que le caribou de la toundra du continent ou même le caribou "des îles arctiques" de la partie sud de l'archipel arctique ait un jour envahi l'une des îles de la Reine-Élisabeth et qu'il ait réussi à s'y établir. Par conséquent, il semble très probable qu'il y ait d'importantes différences environnementales entre les habitats du Grand Nord et les habitats plus au sud, y compris la partie sud de l'archipel arctique. Ces différences ont d'abord exigé l'évolution des caractéristiques physiologiques et morphologiques

que possède maintenant la seule lignée la plus pure des *pearyi* afin qu'elle puisse survivre dans le Grand Nord canadien au fil des temps.

Ainsi, la lignée *pearyi* des îles de la Reine-Élisabeth diffère, tant génétiquement qu'écologiquement des formes *groenlandicus* x *pearyi* qu'on trouve maintenant dans la partie sud de l'archipel arctique, et on ne peut les considérer comme étant équivalentes ou interchangeables en matière de conservation et de protection. Cette distinction a des répercussions particulièrement importantes au niveau de la gestion en ce qui concerne la possibilité de déplacer, de la partie sud de l'archipel arctique aux îles de la Reine-Élisabeth, les formes transitoires du caribou "des îles arctiques" en cas de disparition rapide et totale. D'après les renseignements que nous possédons, cette option ne serait pas valable ou viable sur le plan biologique.

Le caribou de Peary est le seul membre de la famille des cerfs (*Cervidae*) et la seule espèce de *Rangifer* qu'on rencontre dans le Grand Nord canadien. La disparition du caribou de Peary de l'écosystème terrestre du Grand Nord canadien représenterait une perte tragique importante de matériel génétique hautement évolué, et elle créerait un important vide écologique et sociologique dans le patrimoine naturel de l'Arctique canadien.

Le *Rangifer tarandus pearyi* est une sous-espèce uniquement canadienne qu'on rencontre aujourd'hui seulement dans l'archipel arctique canadien et nulle part ailleurs dans le monde. Le nombre total actuel de caribous de Peary (de 3 300 à 3 600) n'est qu'un vestige des anciennes populations, et leur existence précaire dans l'une des régions les plus inhospitalières du monde est en outre menacée par les changements climatiques d'origine anthropogène, la chasse, les perturbations causées par l'exploitation de ressources non renouvelables et la contamination des écosystèmes de l'Arctique du fait de l'activité humaine. Ainsi, en raison de leur situation précaire et de la possibilité d'une plus grande ingérence humaine nuisible, les caribous de Peary des îles de la Reine-Élisabeth devraient être considérés comme une espèce "menacée de disparition".

La tendance dans les évaluations de la population de caribous *groenlandicus* x *pearyi*, de l'île Banks, est à la baisse depuis le début des années 70 et il ne reste aujourd'hui qu'environ 30 % de la population d'antan. Puisque la population de caribous, en raison de sa taille actuelle (d'après les estimations), ne survivra pas au nombre d'animaux abattus actuellement (1989) par les chasseurs (récolte), sans compter le nombre d'animaux abattus antérieurement qui était encore plus élevé, la population de caribous *groenlandicus* x *pearyi*, de l'île Banks, devrait également être considérée comme étant "menacée de disparition".

Si les chiffres des récoltes annuelles qui ont été rapportés chaque année au cours des années 80 sont précis, l'unique évaluation de la population des caribous de l'île Victoria, effectuée en 1980, doit être une grossière sous-estimation de

la taille subséquente de la population. Il aurait fallu que la population de caribous soit environ trois fois plus élevée que celle dénombrée sur l'île Victoria en 1980 pour pouvoir survivre aux taux de récoltes annuelles qui ont été rapportés par la suite. Autrement, le risque de disparition rapide du caribou *groenlandicus* x *pearyi* de l'île Victoria est réel surtout si on y ajoute le taux élevé de mortalité ou la mort des veaux nouveau-nés, qui sont causés par d'autres facteurs. Les renseignements disponibles sur le caribou *groenlandicus* x *pearyi* de la zone de l'île du Prince-de-Galles, de l'île Somerset et de la péninsule de Boothia ne permettent pas d'établir leur nombre de façon certaine. Cependant si la taille de la population a diminué ou si les récoltes annuelles ont de beaucoup augmenté, un déclin futur de la population risque de se produire dans cette zone. Ainsi, les populations de caribous *groenlandicus* x *pearyi* de l'île Victoria et de la zone de l'île du Prince-de-Galles, de l'île Somerset et de la péninsule de Boothia devraient être considérées comme "menacées" jusqu'à ce qu'une évaluation de leur vulnérabilité à une chasse plus soutenue et à l'ingérence humaine soit effectuée ou que la population diminue de façon évidente.

Il y a actuellement trop peu de caribous sur les îles du Roi-Guillaume, de la Royal Geographical Society, Matty et Jenny Lind pour en faire une évaluation distincte significative. On devrait donc regrouper ces populations avec celles du caribou des "îles arctiques" qui, d'après les recommandations, devraient obtenir le statut de "menacés".

B. Distribution

B1. World-Wide

Peary caribou (*Rangifer tarandus pearyi*) with the most pronounced, genetically-based *pearyi* characteristics apparently now occur regularly only on the Queen Elizabeth Islands of the Canadian High Arctic (Fig. 1). Other "arctic-island" caribou (*R. t. groenlandicus* × *pearyi*) that are commonly but mistakenly referred to as "Peary" caribou occur on the southern tier of islands (south of 74°N) in the Canadian Arctic Archipelago and on the Boothia Peninsula (north of 70°N) north of its isthmus (Fig. 2). Some of those transitional forms are phenotypically Peary-like in size and appearance (*R. t. pearyi* > *groenlandicus*) while others (*R. t. groenlandicus* > *pearyi*) are transitional in size and appearance between *pearyi* and the Canadian mainland barren-ground form (*R. t. groenlandicus*). To date, the phenotypic variation in these forms of *Rangifer* is best illustrated by coloured photographs in Jakimchuk and Carruthers (1980: Plates 1 and 2). Currently, there are no viable populations of Peary caribou known on Greenland (Meldgaard 1986). Roby *et al.* (1984) refuted Banfield's (1961) proposal that caribou on coastal northwestern Greenland (the Inglefield Bay population) were intergrades of *pearyi* and *groenlandicus*. Roby *et al.* (1984) indicated that the Inglefield Bay caribou were actually an "environmentally stunted" form of *groenlandicus*. Meldgaard (1986) reported, however, that *pearyi*-sized caribou have occurred in northern Greenland at various periods during the past several thousand years but that current occupation apparently has been reduced to a few migrant Peary caribou from the Canadian Arctic Archipelago, most likely from Ellesmere Island. The last apparent migrant Peary caribou to be killed and reported by Greenland hunters was in 1978 (Roby *et al.* 1984).

Banfield (1961) suggested that the evolutionary line of *pearyi* split from the *groenlandicus* line of *Rangifer* as early as 120 000 BP. There is as yet, however, no evidence from the historical record of *pearyi*-sized caribou on arctic islands until ca. 8000 BP; and then, only for northern Greenland (Meldgaard 1986). Caribou antler material from an unknown form of *Rangifer* found on northern Ellesmere Island also has been dated at ca. 8000 BP (Stewart and England 1986). Thus, the lack of evidence for the presence of ancestral *pearyi* prior to recent times has led to varying conclusions about where *R. t. pearyi* obtained refuge from the Wisconsin-Weichselian glaciation. Most of the current reasoning and circumstantial evidence are for the progenitors of today's Peary caribou having found refuge in the Canadian Arctic Archipelago, probably on the western island of Banks (and possibly southern Prince Patrick Island), possibly on northern Ellesmere Island and also on northern Greenland (Pearyland) (e.g., Rand 1954, Banfield 1961, 1963, Macpherson 1965, Harington 1971, Hakala *et al.* 1985, Røed *et al.* 1986, Røed and

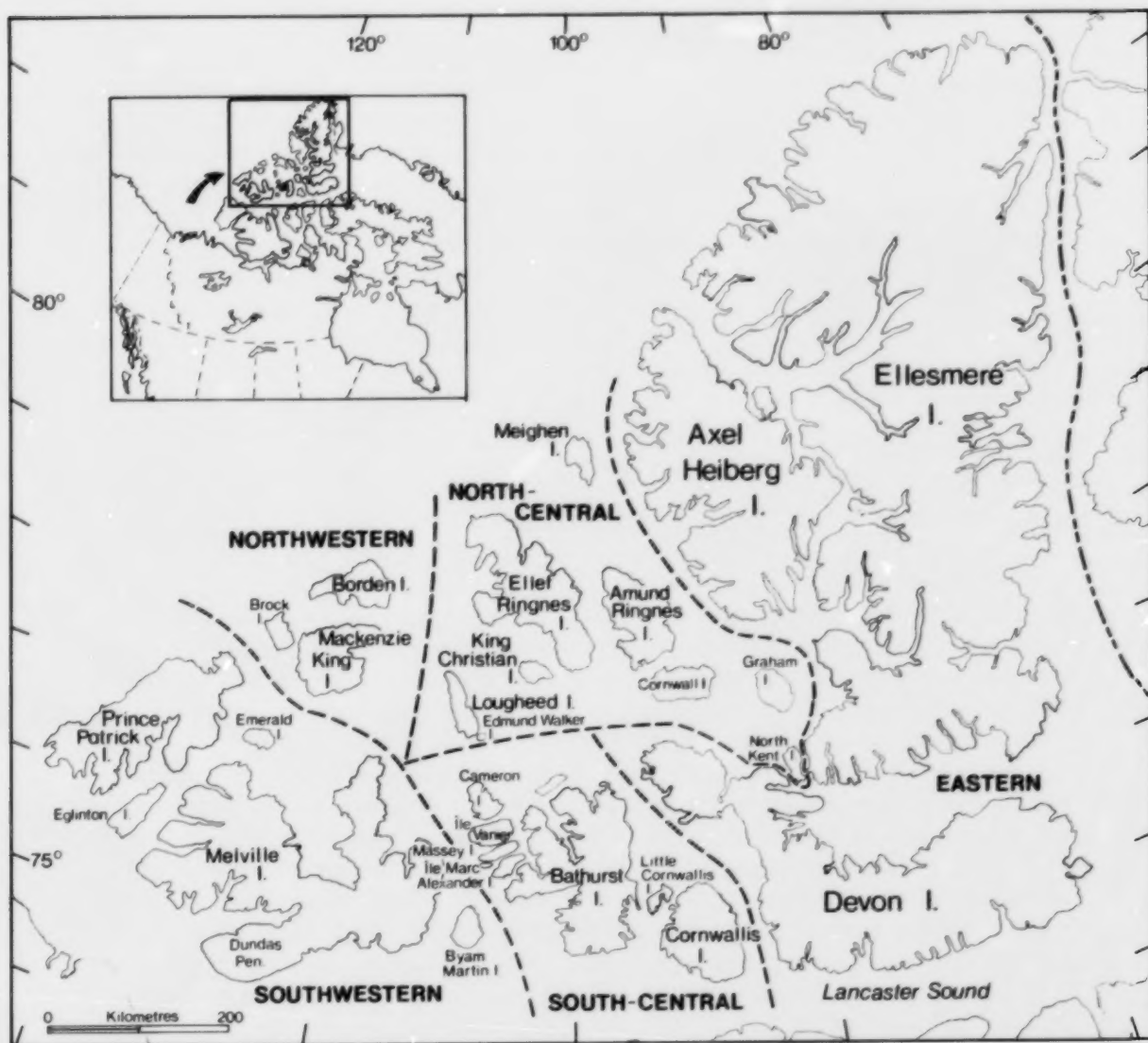


Fig. 1. Current range of the Peary caribou (*Rangifer tarandus pearyi*), Queen Elizabeth Islands, Canadian Arctic Archipelago

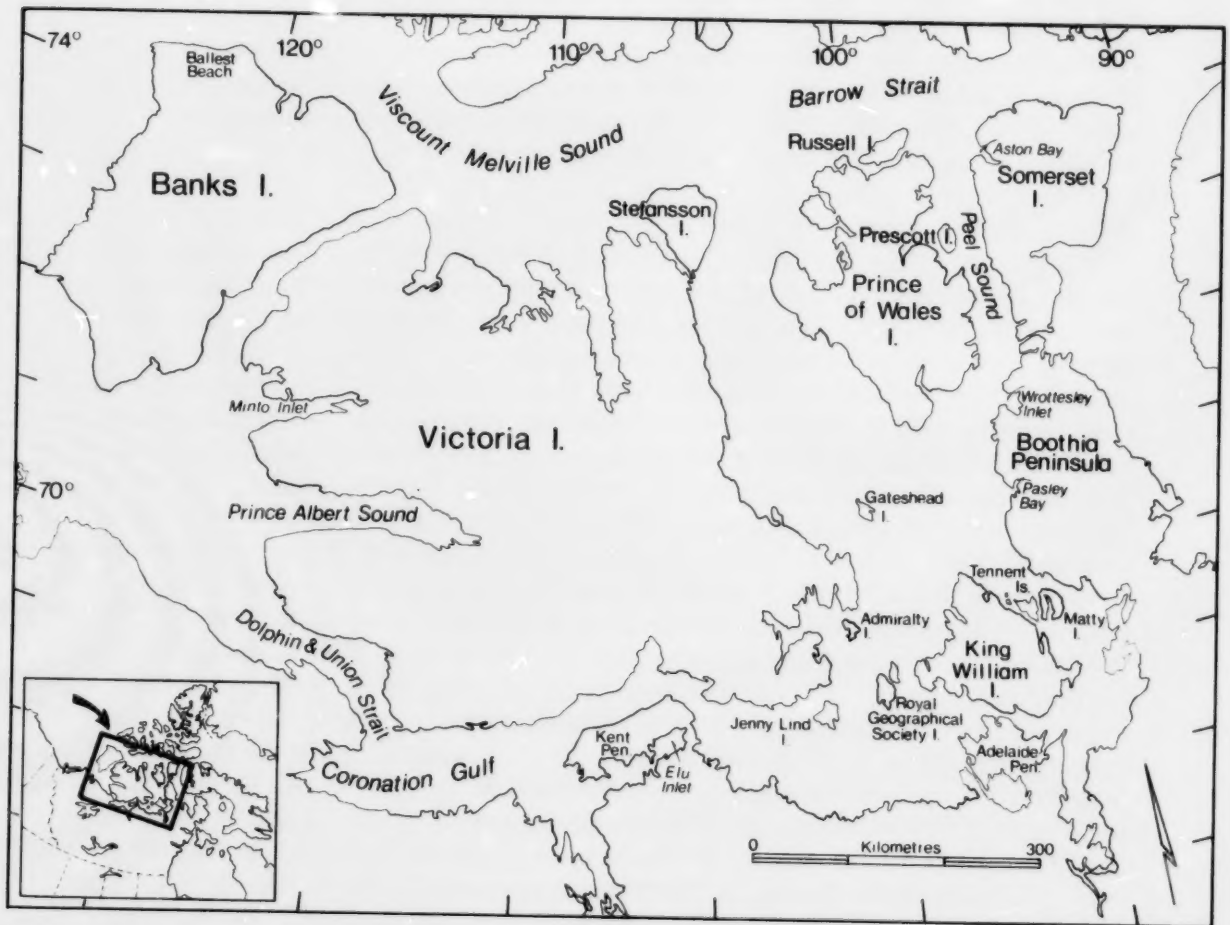


Fig. 2. Current range of "arctic-island" caribou (*Rangifer tarandus groenlandicus* x *pearyi*), southern tier of islands (south of 74°N, excluding Baffin and Bylot islands) and the Boothia Peninsula north of its isthmus, NWT

Whitten 1986; K. H. Røed, pers. commun., 1989). The considerable genetic differentiation between *pearyi* and the continental forms of barren-ground caribou (*R. t. groenlandicus*, *R. t. granti*) and tundra reindeer (*R. t. tarandus*) supports the belief that Peary caribou evolved from an ancestral population different from ancestral populations of the barren-ground and tundra forms (Røed and Whitten 1986; K. H. Røed, pers. commun., 1989). However, Degerbøl (1957) and Meldgaard (1986) have argued against northern Greenland or the Canadian High Arctic Islands having served as refuge for *pearyi*. Peary caribou are not known from Alaska or any Old World location, nor from "Beringia" (the apparent refugium of *groenlandicus* during the Wisconsin-Weichselian ice-age).

B2. Canada

Peary caribou are uniquely Canadian and the typical characteristics of this subspecies are consistently displayed by those Peary caribou on the Queen Elizabeth Islands (Manning 1960, Banfield 1961). Peary caribou on the Queen Elizabeth Islands are a genetically homogeneous inter-island population (Manning 1960, Banfield 1961, Thomas and Everson 1982, Røed *et al.* 1986). In contrast, to date, no evidence has been obtained to even suggest that any regular interchange of caribou is occurring or has occurred in recent times between the Queen Elizabeth Islands and the southern tier of islands (Banks, Victoria, Stefansson, King William, Prince of Wales and Somerset; only barren-ground caribou are known from Baffin and Bylot islands and their satellite islands). Sporadic ingress of some "arctic-island" caribou would be possible, however, especially as the results of widespread wintertime environmental stress (cf. Thomas *et al.* 1976).

The caribou on the arctic islands south of the Queen Elizabeth Islands are referred to as "arctic-island caribou" in this report to emphasize their genetic diversity from *pearyi* and also their likely ecological diversification. The cline of increasing size of the caribou on the southern tier of islands (Banks, Victoria, Somerset and Prince of Wales) compared to caribou on the Queen Elizabeth Islands led Manning (1960), Banfield (1961) and Thomas and Everson (1982) to suggest that those arctic-island caribou originated from intergrades of *groenlandicus* and *pearyi*. Subsequently, Røed *et al.* (1986) documented significant diversion in the genetic endowment of Peary caribou from the western Queen Elizabeth Islands compared with arctic-island caribou from Somerset and Prince of Wales islands and also from caribou on the Boothia Peninsula, based on both the types and frequencies of transferrin alleles found in each group by polyacrylamide gel electrophoresis. However, as yet, the role of natural selection and isolation mechanisms as well as infra-specific interbreeding cannot be discounted in any evaluation of the variation in morphometric measurements and genetic materials examined to date. To continue to refer to those arctic-island caribou as intergrades

could leave an impression that intergradation is still occurring on a large scale, if at all. The existing evidence suggests that intergradation between *pearyi* and *groenlandicus* is not a significant consideration at this time. (1) Heterozygote deficiencies detected in samples of caribou from the western Queen Elizabeth Islands vs. those from Somerset and Prince of Wales islands vs. those from the Boothia Peninsula indicated that present outbreeding among caribou in those areas is insignificant (Røed *et al.* 1986). (2) Current knowledge of the caribou rutting distributions on Banks and Victoria islands suggests continued large scale (or possibly any) intergradation is unlikely (A. Gunn, pers. commun.). (3) There is no evidence for present day occurrence of barren-ground caribou on Somerset or Prince of Wales islands.

Banks Island caribou were first reported as being intergrades of *pearyi* and *R. t. arcticus* (now *R. t. groenlandicus*) by Manning (1960) while investigating the relationship of Peary caribou and barren-ground caribou. He concluded that characteristics of the Banks Island intergrades favoured *pearyi*. However, his classification of Banks Island intergrades as "*Peary caribou*" rather than *pearyi* > *groenlandicus* was seemingly encouraged mainly by his comparison of them to the intergrades of the Dolphin and Union herd that favoured *groenlandicus*, rather than by the actual taxonomical position of the specimens from Banks Island. Banfield (1961) subsequently also identified essentially the same series of specimens as intergrades of *pearyi* and *groenlandicus*. However in his revision of the genus *Rangifer*, he too lumped them as "*Peary caribou*" rather than as intergrade forms of *pearyi* > *groenlandicus*. Had Manning (1960) and Banfield (1961) been taxonomic "splitters", they would have brought out this distinction in genetic diversity among the arctic-island caribou of Banks Island and the Peary caribou on the Queen Elizabeth Islands in a more obvious manner.

The arctic-island caribou of northwestern Victoria Island appear to exhibit the same characteristics favouring *pearyi* as do the intergrades of *pearyi* and *groenlandicus* on Banks Island, and the two groups may have previously existed as a common inter-island population. There is, however, no evidence for large-scale current migrations between Banks and Victoria islands. Evidence for limited, sporadic movements of caribou between eastern Banks Island and northwestern Victoria Island was reported (McEwen 1952a, 1952b, 1955, Manning and Macpherson 1958, Manning 1960, Miller and Gunn 1978a).

The recorded occurrence of *pearyi* on northwestern Victoria Island was based upon Inuit reports and aerial surveys but was not substantiated by specimens (Banfield 1961). Manning (1960) had described, however, the resident arctic-island caribou as intermediate between *pearyi* and the now supposedly extinct caribou on Victoria Island of the Dolphin and Union herd.

The Dolphin and Union herd summered on Victoria Island and returned to the mainland after the rut in early November when the Dolphin and Union Strait and Coronation Gulf were refrozen. The disappearance of the migrant herd parallels the introduction of firearms and by the end of the 1920s the movement had all but stopped (Manning 1960). Loss of the Dolphin and Union herd likely left some members on Victoria Island, though Manning (1960) believed, for unstated reasons, that the number remaining on Victoria was low.

The relationship between those remaining individuals of the Dolphin and Union herd and the then remaining *pearyi* stock is unknown. Caribou numbers remained low on Victoria Island until the 1970s (Gunn, in press). Whether the caribou currently on Victoria Island arose from the remnants of the Dolphin and Union herd or the resident caribou remains unknown. Currently, arctic-island caribou of Victoria Island in the northwestern portion of the island appear similar to the Banks Island caribou. Interchange between these groups appears to be minimal (A. Gunn, F. L. Miller, and D. C. Thomas, unpublished data). The caribou on southern, eastern and central Victoria Island are larger but still are more similar to Peary than barren-ground caribou in pelage colouration and conformation. Their skull measurements are similar to the former individuals of the Dolphin and Union herd (A. Gunn, pers. commun.). A taxonomic study using skull measurements and blood serology is currently underway (A. Gunn, pers. commun.). Most recently, K. H. Røed (pers. commun. 1989) used blood samples collected by Dep. Renewable Resources, GNWT, biologists and found by analysis of transferrin variation that the genotype of Victoria Island caribou has a greater genetic similarity to that of barren-ground caribou from the Beverly herd on the central mainland than to *pearyi* from the Queen Elizabeth Islands.

The taxonomical status of the arctic-island caribou currently found on Stefansson Island is unknown. However, they likely are most closely linked to the caribou of northeastern or eastern Victoria Island.

The taxonomical position of the arctic-island caribou currently found on King William Island (and the lesser islands of the area, including Admiralty, Gateshead, Jenny Lind, Matty, Tennent and Royal Geographical Society) is unknown. Caribou shot on Gateshead Island in March 1986 were similar to those on eastern Victoria Island (A. Gunn, pers. commun.). Only four caribou were seen on King William Island during aerial survey in 1986 and they were Peary-like in appearance (A. Gunn, pers. commun.) as were the few caribou also seen on Matty Island. King William and the lesser islands of the area are reported by Inuit hunters to have Peary-like caribou immigrants or migrants from the southern Boothia Peninsula and some migrant barren-ground caribou from the Adelaide Peninsula (A. Gunn, pers. commun.). The mass numbers of summer migrants from the mainland to King William Island prior to the 1930s (Klutachak

1987) were supposedly composed of barren-ground caribou, but possibly could have also included some arctic-island caribou (cf. Dolphin and Union herd).

The arctic-island caribou of Prince of Wales Island, Somerset Island (and their associated satellite islands) together with the Boothia Peninsula north of its isthmus should not be considered separately, as many of those caribou migrate seasonally within the island-peninsula complex (e.g., Miller and Gunn 1978a, 1979a, 1980, Miller and Kiliaan 1980a, 1981). Large-scale north-south migrations of barren-ground caribou on the Boothia Peninsula continued at least occasionally to Somerset Island prior to the 1930s (Macpherson 1959), and lesser numbers were believed to have crossed from the Boothia to Prince of Wales Island (Manning and Macpherson 1961). Again, these may have been arctic-island or typical barren-ground caribou.

Caribou on Prince of Wales Island were originally classified as a "super" *pearyi* deme by Manning and Macpherson (1961) based on only seven specimens of large adult caribou shot in summer. They concluded that the caribou that they had examined appeared diagnostically as ultra *pearyi*, and showed no significant intergradation with *groenlandicus*. Banfield (1961) accepted the conclusion of Manning and Macpherson (1961) after examining the same seven specimens. This conclusion appears to have been fortified by the belief that although it was known that barren-ground caribou crossed from the Boothia Peninsula to both Somerset and Prince of Wales islands, supposition at that time, had it that they apparently did not intermingle or breed with the island caribou (Macpherson 1959, Manning 1960, Banfield 1961, Manning and Macpherson 1961).

Subsequently, however, Thomas and Everson (1982) examined a relatively large series of caribou shot in late winter on Prince of Wales Island and concluded that intergradation of *pearyi* and *groenlandicus* had taken place. Thomas and Everson (1982) also examined caribou from Somerset Island and the Boothia Peninsula, with individuals from both of these locales also exhibiting apparent intergradation between *pearyi* and *groenlandicus*. Thomas and Everson (1982) believed that they clearly showed, contrary to the conclusions of Manning and Macpherson (1961), that similar phenotypic clines exist on southwestern islands (Banks and Victoria) and southeastern islands (Somerset and Prince of Wales) northward to the Queen Elizabeth Islands. They further stated that the so-called Prince of Wales ultra *pearyi* of Manning and Macpherson (1961) was most certainly a summer visitor to Prince of Wales Island (possibly from Victoria Island), similar to the five large caribou bulls in their August 1978 sample (Thomas and Everson 1982). Such large-sized males could also have come as summer visitors from the Boothia Peninsula, based on spring observations of large male caribou

on the sea ice, crossing from the Boothia to Prince of Wales (cf. Miller and Kiliaan 1980a, 1981).

Therefore, the arctic-island caribou of Prince of Wales Island, Somerset Island and caribou of the northern Boothia Peninsula include apparent intergrades of *pearyi* and *groenlandicus* (some *pearyi* > *groenlandicus* and some *groenlandicus* > *pearyi*) and possibly an ultra *pearyi* deme and also some *groenlandicus* individuals. In terms of phenotypic and genetic characteristics these arctic-island caribou have diversified from the Peary caribou found on the Queen Elizabeth Islands (cf. Røed *et al.* 1986).

The characteristics of Peary caribou are expressed in ascending clines from south to north on the Canadian Arctic Archipelago (Manning 1960, Banfield 1961, Thomas and Everson 1982) and marked genetic diversity has been shown among each of these clines (Røed *et al.* 1986; K. H. Røed, pers. commun., 1989). Therefore, in terms of the greatest development of *pearyi* characteristics and genetic endowment, essentially all of the southern tier of islands in the archipelago have been lost by Peary caribou to arctic-island caribou that may have originated as intergrades of *pearyi* and *groenlandicus* and also through the forces of extreme natural selection or isolation mechanisms. Thus, over half (ca. 53%) of the original probable area of usable range of Peary caribou in Canada has been lost since historic times. Peary caribou would be at a disadvantage when competing with the larger arctic-island caribou on the southern tier of islands and especially when competing with *groenlandicus* on the mainland (or on Baffin or Bylot islands). Thus, in the presence of other forms of *Rangifer* and under present climatic conditions the Peary caribou could not extend its range southward beyond the Queen Elizabeth Islands without changing its typical characteristics such as small size. Thus, the Queen Elizabeth Islands of the Canadian Arctic Archipelago are all-important to the current and future preservation of the Peary caribou and its gene pool. It now appears that viable populations of these Peary caribou occur only on the Queen Elizabeth Islands of Canada.

Peary-like caribou sporadically occur on mainland areas possibly as a result of forced movements when widespread forage unavailability is brought on by deep snow and/or icing conditions on their island home ranges. Environmentally forced movements have been suggested for caribou on Banks Island (McEwen 1955, Manning and Macpherson 1958). Such occurrences are usually on the mainland coast, but in winter 1963-64 a Peary-like caribou (most likely from Banks Island) was killed at Old Crow in the Yukon: an adult female that most closely resembled a Dolphin and Union herd intergrade (Youngman 1975). Low numbers of arctic-island caribou from Victoria Island regularly cross the sea ice to the mainland in November, winter in the area of Elu Inlet, then return in

April to southeast Victoria Island; thus, mimicking on a small scale the seasonal migration pattern of the Dolphin-Union herd (A. Gunn, pers. commun.).

C. Protection

Peary caribou and the arctic-island caribou are the management responsibility of the Government of the Northwest Territories. There are no restrictions on subsistence hunting of caribou by holders of "General Hunting Licences". However, a voluntary ban was imposed in 1975 by Inuit of Resolute Bay on hunting caribou on Bathurst Island after the massive 1973-74 winter die-off (Freeman 1975). In 1982, the Resolute Bay Inuit extended their ban on caribou hunting to include Cornwallis Island and those small islands interjacent to Bathurst and Cornwallis (Ferguson 1987). In 1986, the Grise Fiord Inuit in response to a lack of caribou imposed a 10-year ban on caribou hunting on a large part of Ellesmere Island (Ferguson 1987). The people of Grise Fiord currently obtain their caribou meat by purchasing it from the Resolute Bay Hunters and Trappers Association.

Arctic-island caribou on the southern tier of islands and caribou on the Boothia Peninsula are also subjected to low levels of meat and sport hunting by non-native resident hunters. A limited number of "*commercial tags*" (220 available in 1988: 95 Sachs Harbour; 75 Cambridge Bay; and 50 Holman) are issued annually to holders of "General Hunting Licenses" (A. Gunn, pers. commun.). These tags allow the sale of meat to individuals or commercial establishments within the Northwest Territories, guided trophy hunting for non-residents and local sales of meat to hotels or individuals.

D. Population Size And Trend

Determination of population sizes and trends for Peary caribou on the Queen Elizabeth Islands and the arctic-island caribou on the southern tier of islands in the Canadian Arctic Archipelago is handicapped by insufficient survey data. Comparative survey information exists only for the southwestern and south-central Queen Elizabeth Islands and Banks, Prince of Wales and Somerset islands (and those data bases are variable and fragmentary). The handicap is increased as much of the existing information on numbers of caribou has been derived from only a portion of an island rather than the entire island or a single island without regard to the effect of inter-island migrations. Additionally, surveys were frequently flown against a background of snow, or even worse when the ground was mottled snow cover and snow free areas. Against such a background, the caribou are inconspicuous from the air. Thus, the following discussions of trends in population size are based on only those aerial surveys least likely to have survey problems. However, other survey results are used when such use apparently adds to the evaluation or when no other data exist.

D1. *Queen Elizabeth Islands*

Numbers of Peary caribou have declined significantly throughout their range on the Queen Elizabeth Islands during the past 26 years (1961-87) and the decline is likely to continue in the absence of any marked climatic improvement. The first estimate of 25 845 Peary caribou on the Queen Elizabeth Islands was obtained by aerial survey in summer 1961 (Tener 1963).

Available information indicates that by 1987, there were then only 3300-3600 Peary caribou left in the Canadian High Arctic and all occurred on the Queen Elizabeth Islands. Almost 75% of those Peary caribou occur on several islands which are only about 1/5 of the landmass of the Queen Elizabeth Islands. Only the major islands of Melville, Bathurst and Prince Patrick and their lesser satellite islands have potential for supporting relatively high densities of Peary caribou. Thus, nearly 45% of the landmass of the Queen Elizabeth Islands serves merely as a reservoir that supports only extremely low density populations over the long-term on a year-round basis.

Southwestern Queen Elizabeth Islands

The island complex of Melville, Prince Patrick, Eglinton, Byam Martin and Emerald has a landmass of about 61 310 km², which is about 15% of the entire Queen Elizabeth Islands (Table 1). This land area continues to be the most important island complex for Peary caribou within the Queen Elizabeth Islands. In 1961, nearly 60% of all the Peary caribou estimated on the Queen Elizabeth

TABLE 1

Numbers of Peary Caribou on the 10 Queen Elizabeth Islands for which 26-year trends are available, Canadian High Arctic, 1961-1987

Island	Size of Island (km ²)	Estimated Number			
		1961 ^a	1973 ^b	1974 ^b	1985-87 ^c
Melville	42 220	12 799	3422	1679	943
Bathurst	16 090	2723	712	231	495
Prince Patrick	15 830	2254	807	621	154
Eglinton	1550	204	12	18	79
Lougheed	1300	1325	66	0	0
Varier	1130	396	24	10	67
Cameron	1060	235	9	12	51
Emerald	550	161	39	20	14
Alexander	490	198	0	0	38
Massey	440	13	52	0	76
All 10 Islands	80 660^d	20 308^e	5143	2591	1917
% decrease from 1961			74.7	87.2	90.6

^a From Tener (1963).

^b From Miller *et al.* (1977a).

^c From Miller (1987a, 1987b, 1988).

^d Equals 19.4% of the entire landmass of all 26 Queen Elizabeth Islands that are greater than 400 km² each in size.

^e Equals 78.6% of the 25 845 Peary caribou estimated on the Queen Elizabeth Islands in summer 1961 (Tener 1963).

Islands (N = 25 845) occurred on this island complex (Table 1), with a mean density of 25.1 caribou · 100 km⁻². By summer 1973, the estimated number of Peary caribou within the complex had dropped to 28% (mean density, 7.1 caribou · 100 km⁻²) of the 1961 estimate. Then, in the extremely severe winter of 1973-74 nearly half (46%) of the caribou remaining in summer 1973 died and the estimated number of caribou in summer 1974 was reduced to 15% (mean density, 3.8 caribou · 100 km⁻²) of the 1961 estimate. Finally, by summers 1986 and 1987 the estimated number of Peary caribou within this island complex had declined further to only about 8% (mean density, 2.1 caribou · 100 km⁻²) of the 1961 estimate.

The existing data indicate that Peary caribou on the southwestern Queen Elizabeth Islands declined by nearly 92% between 1961 and 1987. There is no evi-

dence for any periods of stability or reversal in the overall decline, although some brief periods of reprieve might have occurred. This inter-island population shows no apparent signs of recovery in the near future. The population is too small to sustain any harvest beyond a nominal level.

The Peary caribou on Melville Island have not become extinct by 1983 as forecasted by a worst-case scenario by Thomas and Joly (1981). Also, adult male caribou contrary to Thomas and Joly's (1981) belief now appear well-represented in the population on Melville at ca. 32% ($N = 337$ 1+ yr-old caribou) seen in July 1987 (Miller 1988). However, at least a decade must pass before the Peary caribou population on Melville Island could likely increase sufficiently to sustain an annual harvest of any appreciable size.

The rapidly increasing number of muskoxen (*Ovibos moschatus*) within this island complex (Miller 1988) is possibly significant in the ecology of Peary caribou. The increase in the muskox numbers will enlarge the prey base for wolves (*Canis lupus*). If the wolves respond numerically to the greater prey base, the wolves could then seriously affect the caribou population, as even incidental predation could be significant on a proportionate basis for the markedly reduced number of caribou.

South-central Queen Elizabeth Islands

The total landmass ($26\,620\text{ km}^2$) of the island complex of Bathurst, Cornwallis, Vanier, Cameron, Alexander, Massey and Little Cornwallis is about 6% of the entire Queen Elizabeth Islands (Tables 1, 2 and 3). This land area is the second-most and the only other important area of the Queen Elizabeth Islands in terms of the past and likely future potential for eventually producing, at least, moderate numbers of harvestable Peary caribou.

In 1961 nearly 14% (3608) of the Peary caribou estimated on the Queen Elizabeth Islands occurred within this island complex (Tables 1, 2 and 3), with a mean density of $13.6\text{ caribou} \cdot 100\text{ km}^{-2}$. By summer 1973 the estimated number of Peary caribou was about 22% (797 at a mean density of $3.0\text{ caribou} \cdot 100\text{ km}^{-2}$) of the 1961 estimate. Then, as elsewhere throughout at least the western and central Queen Elizabeth Islands, a catastrophic die-off (ca. 67%) occurred during the winter of 1973-74 and by summer 1974, the estimated number of Peary caribou had been reduced to only about 7% (262 at a mean density of $1.0\text{ caribou} \cdot 100\text{ km}^{-2}$) of the 1961 estimate. In summer 1985, however, the estimated number of caribou had increased almost three-fold from 1974 (mean density, $2.7\text{ caribou} \cdot 100\text{ km}^{-2}$). However, the 1985 summer estimate still only represents about 20% (727) of the Peary caribou estimated within this island complex in 1961. Thus, the overall trend has been steeply downward from 1961 to at least 1974; then,

likely a gradual upswing in the early 1980s. Fischer and Duncan's (1976) estimates of 332 caribou in August 1974 and 361 caribou in June 1975 add further support to the evidence for a catastrophic decrease from summer 1973 to summer 1974 and are in close agreement with Miller *et al.*'s (1977a) estimate of 256 ± 143 in summer 1974. That the turnaround was delayed until some time in the 1980s is supported by the estimate of 289 ± 93 caribou on Bathurst Island in summer 1981 (Ferguson 1987). Whether the changes observed and estimated in 1985 are the beginning of a relatively long-term trend or only a brief reversal in direction cannot be discerned at this time. However, the inter-island population within this island complex is not yet at a level that would sustain any appreciable level of annual harvests. Self-restraint and the continuance of the total ban on caribou hunting on Bathurst Island should be encouraged for at least the next several years. However, a token harvest of less than 10 male caribou may be necessary for the maintenance of cooperation as 12 years (1975-87) of no caribou hunting on Bathurst Island have already passed.

Northwestern Queen Elizabeth Islands

This complex of islands, sometimes called the *Prime Minister Group*, including Mackenzie King, Borden and Brock (8610 km^2) is only 2% of the entire Queen Elizabeth Islands (Table 2). In 1961 nearly 16% of all the Peary caribou estimated on the Queen Elizabeth Islands occurred on this island complex (Table 2). The unusually high mean density of $46.6 \text{ caribou} \cdot 100 \text{ km}^{-2}$ in summer 1961 was probably a seasonal overflow of summer migrants from the major islands of Melville, Prince Patrick and even Bathurst. Evidence from tracks on the sea ice and changes in numbers of caribou occurring there among years supports this assumption (Stefansson 1921, Macpherson 1961, Tener 1963, Miller *et al.* 1977a). Survey results from April 1973 and April 1974 indicated that only a remnant population of about 1% of the 1961 estimate still occurred within the complex (Miller *et al.* 1977a). No subsequent surveys have been flown but hearsay information from non-wildlife people who were in the area during summers in the late 1970s and the early 1980s suggest that caribou continue to be rare there.

This island complex is unsuitable for year-round occupation by ungulates at high densities and the landmass is relatively insignificant in size to the remainder of the Queen Elizabeth Islands. Thus, this island complex's real value to Peary caribou is as supplementary summer range during periods of population highs on the southwestern and south-central islands and as a low density reservoir during population lows on other areas.

TABLE 2

Numbers of Peary Caribou on the 5 Queen Elizabeth Islands for which 13-year trends are available, Canadian High Arctic, 1961-1974

Island	Size of Island (km ²)	Estimated Number			
		1961 ^a	1973 ^b	1974 ^b	1985-87 ^c
Mackenzie King	5050	2192	0	36	(27)
Bordon	2800	1630	19	10	(7)
Byam Martin ^d	1160	—	43	6	98
Brock	760	190	28	14	(10)
Little Cornwallis	410	0	0	9	(7)
All 5 Islands	10 180 ^e	4012 ^f	90	75	149
% decrease from 1961			97.8	98.1	(96.3)

^a From Tener (1961).

^b From Miller *et al.* (1977a).

^c Extrapolated values (in parentheses) were obtained by assuming percentage loss between 1985-87 and 1974 in Table 1 (26.0%) is applicable to these four islands during the same time period.

^d Trend for Byam Martin is based on 14 years (1973-1987).

^e Equals only ca. 2.5% of the entire landmass of all 26 Queen Elizabeth Islands that are greater than 400 km² in size.

^f Equals 15.5% of the 25 845 Peary caribou estimated on the Queen Elizabeth Islands in summer 1961 (Tener 1963).

North-central Queen Elizabeth Islands

The islands of Ellef Ringnes, Amund Ringnes, Cornwall, Graham, Loughheed, Meighen, King Christian and North Kent (23 700 km²) represent about 6% of the area of the entire Queen Elizabeth Islands (Table 3). The only population estimate for this island complex was obtained in 1961 when about 8% of all the Peary caribou estimated on the Queen Elizabeth Islands occurred in this island complex (Tables 1, 2 and 3), with a mean density of 9.1 caribou · 100 km⁻². Only Loughheed Island has been aerially resurveyed since 1961. Only 56 caribou were estimated on Loughheed in April 1973 and only one was seen there in April 1974 (Miller *et al.* 1977a). More recently, only one cow-calf pair (and a mature bull on Edmund Walker Island just off the southeast coast of Loughheed) were seen during an aerial survey of Loughheed Island in July 1985 (Miller 1987a).

The relatively high number of caribou in this area in summer 1961 was likely also an overflow of summer migrants from southwestern and south-central islands. This condition is especially true for Loughheed Island, which seemingly

TABLE 3

Numbers of Peary Caribou on the 11 Queen Elizabeth Islands for which only one or no estimate exists, Canadian High Arctic

Island	Size of Island (km ²)	Estimated number 1961 ^a	Indirectly extrapolated number 1985-87 ^b
Ellesmere	196 240	200	
Devon	55 250	150	
Axel Heiberg	43 180	300	
Ellef Ringnes	11 300	114	
Cornwallis	7000	43	
Subtotal	312 970^c	807^d	(807)^e
Amund Rignes	5260	452	
Cornwall	2260	266	
Subtotal	7520^f	718^g	(531)^h
Graham	1380	-	
Meighen	960	-	
King Christian	650	-	
North Kent	590	-	
Subtotal	3580ⁱ	-	-
Total (all 11 islands)	324 070^k	1525^m	(1338)ⁿ

^a From Tener (1963).

^b See footnotes e, h and n.

^c Equals 75.4% of the entire landmass of all 26 Queen Elizabeth Islands that are greater than 400 km² each in size.

^d Equals only 3.1% of the 25 845 Peary caribou estimated on the Queen Elizabeth Islands in summer 1961 (Tener 1963).

^e Empirical and hearsay evidence suggests that Tener's (1963) 1961 estimates for these five islands were low; so they likely remain approximately equal in 1985-87.

^f Equals only 1.8% of the entire landmass under consideration.

^g Equals only 2.8% of the 25 845 Peary caribou estimated on the Queen Elizabeth Islands in summer 1961 (Tener 1963).

^h Obtained by assuming percentage loss from 1961 was equal to the loss that occurred between 1985-87 and 1974 in Table 1 (26.0%).

ⁱ Equals only 0.9% of the entire landmass under consideration.

^k Equals 78.1% of the entire landmass under consideration.

^m Equals only 5.9% of the 25 845 Peary caribou estimated on the Queen Elizabeth Islands in summer 1961 (Tener 1963).

ⁿ This extrapolated value suggests a 12.3% reduction in the number of Peary caribou within this complex of 11 islands from 1961 to 1985-87.

could not have supported such a high density of caribou on a year-round basis. Hearsay evidence from non-wildlife people in the area during summer in the 1980s also suggests that densities of caribou continue to be low on the island. Like the northwestern islands this island complex is likely only suitable for supporting summer migrants, some times at relatively high densities, but could only sustain low density reservoir populations during wintertime.

Eastern Queen Elizabeth Islands

This complex includes the three largest of the Queen Elizabeth Islands: Ellesmere, Devon and Axel Heiberg, with a total landmass of 294 670 km² or about 71% of the entire Queen Elizabeth Islands (Table 3). In 1961 less than 3% of all the Peary caribou estimated on the Queen Elizabeth Islands occurred in this island complex (Table 3), with an extremely low mean density of 0.2 caribou · 100 km⁻². The islands have not been surveyed since 1961, but hearsay information from biologists and non-wildlife people in the area indicates that while Tener's (1963) 1961 estimates for the three islands within this complex might be on the low side, they are not significantly so. For unknown reasons, these large islands have apparently never supported large numbers of Peary caribou.

Until the ban on caribou hunting in the mid 1980s, the limited harvest of Peary caribou on southern Ellesmere Island likely seriously affected the population. This problem was first identified in the early 1970s, when Riewe (1973) reported that then current annual harvests averaged 26 caribou, only slightly more than half as large as the 43 averaged in the early 1980s. In 1986-87 the harvests dropped to 25 caribou annually (M. A. D. Ferguson, pers. commun.).

There is no reason to believe that these islands will ever serve as anything but very low density reservoirs for Peary caribou. The caribou population in this island complex will likely never be able to sustain annual harvests of any significant level, unless climatic change leads to more favourable conditions.

D2. Southern Tier of Islands—South of 74°N

Population estimates of caribou on the southern tier of islands (also known as the mid-arctic islands of the Canadian Arctic Archipelago) have no common benchmark starting point and the associated trends are for the most part vaguely discernible and their interpretation is provisional at best. Detailed annual harvest data for caribou on these islands are only available since 1984 for Victoria Island and 1987 for Banks Island (A. Gunn, pers. commun.).

The available estimate for the entire southern tier of islands (excluding Baffin and Bylot islands) and the Boothia Peninsula (north of 70°N) is 18 000-22 000. Existing annual harvest data and our knowledge of the species lead to the con-

clusion that this estimate must be too low. Even 20 000 caribou could not collectively sustain the annual combined harvests of about 4000 per year (or 20% annually of all the caribou assumed to be on those islands). The alternative suggestion is that one or more of the population estimates is a substantial underestimate, most likely the 1980 estimate of caribou on Victoria Island.

Victoria-Stefansson islands

Together Victoria Island (217 290 km²) and Stefansson Island (4460 km²) represent ca. 61% of the 365 880 km² landmass of the 11 islands in the southern tier in the Canadian Arctic Archipelago (excluding Baffin and Bylot islands and their lesser satellite islands) that each exceed 400 km² in size (Table 4). Victoria Island seemingly has the greatest potential for long-term support of a high density population of caribou. Manning (1960) described the disappearance of the Dolphin and Union herd of caribou that used to summer on Victoria Island. Subsequently, caribou have increased in number on Victoria Island (Gunn, in press) and ongoing studies are describing the seasonal movements and taxonomy of the caribou (e.g., Gunn and Stenhouse 1988). The caribou of Victoria Island have been aerially surveyed only once and that survey did not cover Stefansson Island or northeast Victoria Island.

In view of the fact that 1982-87 reported annual harvests of caribou on Victoria Island are 1700-2300 (Gunn *et al.* 1986, A. Gunn, pers. commun.), the August 1980 population estimate (Table 4) must be considered low, as it is biologically impossible for the species to sustain such yields over time. Even at the upper limit of the 95% confidence level of the 1980 estimate, the 10 000 caribou could not sustain a 17-23% yearly harvest without declining markedly within several years' time.

Hunters report increasing numbers of caribou on southern Victoria Island (A. Gunn, pers. commun.) which suggests that as annual mean harvests are approaching or exceed 2000 caribou, the current population is more likely actually about 4-fold the 1980 estimate (i.e., ca. 30 000 strong), if the population is sustaining itself. The current trend for caribou on Victoria Island has not been measured, however. Therefore, the magnitude of the apparent necessary increase could be misleading. If so, the caribou population on Victoria Island could be in an initial stage of decline, even though recent numbers might seem high to the hunters. Redistribution of caribou on seasonal ranges without significant increase in number could create a possibly false impression of plenty.

TABLE 4
Numbers of arctic-island caribou (*Rangifer tarandus groenlandicus x pearyi*) on the southern tier of islands (south of 74°N) in the Canadian Arctic Archipelago and on the Boothia Peninsula (north of 70°N), Northwest Territories

Year Estimate Obtained	Estimate	% Decrease From Initial Estimate	Time Lapse In Years	Source
<i>Victoria (217 290 km²) and Stefansson (4460 km²) equals 221 750 km² 60.6% of the entire landmass</i>				
1980	7936	—	—	Jakimchuk & Carruthers (1983)
<i>Banks (70 030 km²), 19.1% of the entire landmass</i>				
1972	12 098	—	—	Urquhart (1973)
1979-80 ^a	7820	35	7-8	Vincent (1979, 1980)
1982	10 046	17	10	Latour (1985) ^b
1985	5918	51	13	McLean <i>et al.</i> 1986 ^c
1987	6197	49	15	B. McLean (pers. commun.) ^d
1989	3547	71	17	McLean and Fraser (1989) ^e
<i>Prince of Wales (33 340 km²), Somerset (24 790 km²), Russell (940 km²) and Prescott (410 km²) equals 59 480 km², 16.3% of the entire landmass, plus Boothia Pen^f (ca. 26 000 km²)</i>				
1974	6308	—	—	Fischer & Duncan (1976)
1975	6569	—	1	Fischer & Duncan (1976)
1980	5675	10	6	Gunn & Miller (1983) ^g
<i>King William (13 110 km²) Royal Geographical Society Islands (610 km²), Matty (480 km²) and Jenny Lind (420 km²) equals 14 620 km², 4.0% of the entire landmass</i>				
1986 (only 4 caribou seen on Survey of King William Island)		—	—	A. Gunn (pers. commun.)

^a Only southern half of Banks Island was surveyed in 1979 and northern half in 1980 (Vincent 1979, 1980).

^b Estimate of 7233 1+ yr-old caribou divided by 0.72 to include 28% calves, (Latour 1982) so that 1982 estimate would be in agreement with earlier ones that included calves in the estimate.

^c Estimate of 5000 1+ yr-old caribou plus 918 calves calculated from data in Table 3 and Appendix C of McLean *et al.* (1986); so that 1985 estimate would be in agreement with earlier ones that included calves in the estimate.

^d Estimate of 4400 1+ yr-old caribou divided by 0.71 to include 29% calves (A. Gunn, pers. commun.) so that 1987 estimate would be in agreement with earlier ones that included calves in the estimate.

^e Estimate of 2660 1+ yr-old caribou divided by 0.75 to include 25% calves (McLean and Fraser (1989) so that the 1989 estimate would be in agreement with earlier ones that included calves in the estimate.

^f Entire Boothia Pen. north of 70°N was aerially surveyed only in 1985, with a tentative estimate of 4000-5000 (A. Gunn, pers. commun.).

^g Estimate of 5022 1+ yr-old caribou divided by 0.87 to include 13% calves; (Gunn and Miller 1983) so that 1980 estimate would be in agreement with earlier ones that included calves in the estimate.

Banks Island

Banks Island (70 030 km²) is about 19% of the landmass of the southern tier of islands (Table 4). Differences between the 1971 and 1972 survey results and the results from the five surveys from 1979 to 1987 (Table 4) indicate that the caribou population on Banks Island was declining throughout the 1970s and into the early 1980s. The decline cannot be explained alone by the reported annual harvests during that time period. However, a major winter die-off of caribou occurred on Banks Island in winter 1977-78 (Morrison 1978). Thus, the combined effects of severe winters and hunting pressure seemingly have contributed to this decline. The 1985 and 1987 estimates of the size of the caribou population on Banks Island (Table 4) and annual harvests of 400-600 caribou suggests that hunting pressure alone could have accelerated the population decline in recent years. This unfavourable condition would be compounded if the caribou are also sporadically subjected to major die-offs during severe winters as they apparently have been in the past (cf. McEwen 1955, Manning and Macpherson 1958, Morrison 1978, Vincent 1979).

Most recently, McLean and Fraser (1989) have reported a further drastic decline in the number of arctic-island caribou on Banks Island (Table 4). When their 1989 summer population estimate of 2660 1+ yr-old caribou is adjusted for the 25% calves in the population, the population is still less than 30% of the 1972 estimate for caribou on Banks Island (Table 4). This significant reduction in the Banks Island caribou population from the early 1970s to present is attributed mainly to overwinter mortality and human harvests (cf. McLean and Fraser 1989). At present, however, due to the current reduced size of the caribou population, annual harvest alone is now capable of causing continual decline (and rapidly so, if the annual rates of kill are increased). This serious situation on Banks Island warrants special attention, as the current drastic decline and any near future noticeable further decrease in the caribou population could be mistakenly attributed to a supposed competition between caribou and muskoxen rather than to the real causes (see G. Limiting Factors).

Prince of Wales Island-Somerset Island-Boothia Peninsula Complex

The islands of Prince of Wales, Somerset, Russell and Prescott are included in this complex, with a total landmass of about 59 480 km² or about 16% of the southern tier of islands (Table 4). Also, included in this complex is the Boothia Peninsula north of 70°N, with a land area of ca. 26 000 km² (Table 4).

Many if not most of the caribou migrate freely among the islands and the peninsula within this complex (e.g., Miller *et al.* 1982). Thus, the existing popula-

tion estimates suffer from not covering all three major areas within the island-peninsula complex at the same times. This condition confounds evaluation of the trend for the estimates of size of the inter-island (peninsula) population.

The best estimates appear to be for summers 1974, 1975 and 1980 (Table 4). However, the timing of the surveys in 1974 and 1975 were too early, as inter-island or island-peninsula migrations would have still been occurring in June of those years. Subsequently, the survey results are lacking because the Boothia Peninsula was not surveyed in July 1980. The June 1985 estimate of 4000-5000 caribou on the Boothia Peninsula north of ca. 70°N (Gunn and Ashevak, in prep.) in the absence of survey information from the remainder of the complex leads to at least three possible interpretations: (1) the number of caribou has increased on the northern Boothia Peninsula since 1975; however, (2) many caribou might not have yet moved from the Boothia Peninsula to Prince of Wales or Somerset islands before the aerial survey took place in June 1985; or (3) for unknown reasons, caribou that normally summered on Prince of Wales and Somerset islands moved to the Boothia Peninsula before the aerial survey took place and inflated the number of caribou seen there in June 1985.

The existing information for this complex (Table 4) suggests that an inter-island (peninsula) population of about 6000 caribou has existed within the area since at least 1974. The suggested annual harvest of 200-300 caribou from Prince of Wales and Somerset islands is seemingly within the sustainable capacity of the estimated population. The relatively high recent annual harvests (1983-84) of 1100-1300 caribou by Spence Bay residents could impact on this population, but that effect depends on what proportion of the annual kills come from the caribou on this inter-island (peninsula) population or from the year-round resident mainland caribou. Currently, however, there is no segregation of harvest data from the Boothia Peninsula to allow an evaluation of this potentially serious situation.

King William Island and some lesser islands

This complex includes the islands of King William, Royal Geographical Society, Matty and Jenny Lind, with a total landmass of about 14 620 km² or only 4% of the southern tier of islands (Table 4).

King William Island once supported large numbers of summer migrants from the mainland, which were presumed to have been barren-ground caribou. However, those large, seasonal migrations declined rapidly in the 1920s, which paralleled the introduction of firearms into the area and a severe winter. Then the migrations from the mainland apparently ceased in the 1930s. Subsequently, caribou apparently have remained rare on King William Island. The only aerial survey of King William Island was carried out in June 1986 under poor survey conditions. Only two caribou cows and newborn calves were seen (Gunn and Lam-

bert, in prep.), although hunters report increasing numbers of caribou on the island. Thus, no population estimate exists for the complex; but all existing hearsay information indicates that few caribou currently occur within this island complex. The potential for this island complex to support a significant year-round population of caribou is limited by the size of the available range and, seemingly, also by the probable restricted availability and poor quality of the predominantly lowland winter ranges.

E. Habitat

E1. Distribution

Icefields, bare ground, and rock restrict the areas of suitable foraging habitat for Peary caribou to a relatively small percentage of the total area of the arctic islands (Gunn *et al.* 1981). Parker and Ross (1976) described summer ranges used by Peary caribou from sites on Melville and Axel Heiberg islands. Winter and summer range types used by arctic-island caribou have been described along the proposed routes of the Polar Gas pipeline on Prince of Wales and Somerset islands (Russell *et al.* 1978), and Wilkinson *et al.* (1976) described summer range on Banks Island.

Peary caribou and arctic-island caribou use poorly to moderately vegetated xeric to mesic habitats (e.g., Thomas and Edmonds 1983, 1984). Forage of high digestibility is selected but when unavailable, the proportions of low digestibility forages are increased (Thomas and Kroeger 1980). Summer foraging areas often occur on more mesic habitats such as slopes of river valleys and upland plains with sedges (*Carex* spp.), willow (*Salix arctica*), grasses and forbs especially *Saxifraga oppositifolia* (Gunn *et al.* 1981). In winter, caribou are found on more exposed sites with shallow snow cover such as hilltops and raised beach ridges (Gunn *et al.* 1981). On Somerset Island, the winter range is mainly broken rock outcrops where the snow is variable in depth but usually soft or loose and not usually crusted (Thomas *et al.* 1977). Winter foraging sites tend to be xeric and poorly vegetated with *Dryas integrifolia*, *Saxifraga oppositifolia*, *Salix arctica*, sedges and foliose lichens important species, but regional differences are evident (Wilkinson and Shank 1974, Parker and Ross 1976, Thomas *et al.* 1976, 1977, Wilkinson *et al.* 1976, Parker 1978, Russell *et al.* 1978, Shank *et al.* 1978, Thomas and Broughton 1978, Thomas and Edmonds 1983, 1984).

Caribou characteristically feed while walking and this mobility reduces foraging pressure on the vegetation (Parker and Ross 1976, Miller *et al.* 1982). Grasses and sedges have a high root:shoot ratio and manifest a capacity for recovering from clipping and probably from foraging (Babb 1978). Woody prostrate shrubs such as *Dryas integrifolia*, *Saxifraga oppositifolia* and *Salix arctica* are physically more resistant to damage such as by trampling, but probably less resistant to heavy pruning (Babb 1978). On the North American mainland, foliose lichen communities are vulnerable to trampling damage by caribou (e.g., Pegau 1970). On the Arctic Islands the low numbers of caribou and relative unimportance of the poorly developed lichen stands in their diet apparently minimize the effect of caribou on lichens (e.g., Thomas and Edmonds 1983). The low densities of Peary caribou, the relative small size of their groups and their mobility while foraging

usually prevent overuse of forage sites despite the characteristically low productivity of such ranges (Gunn *et al.* 1981).

Calving, postcalving and rutting areas likely are critical habitats, and the caribou using them are particularly vulnerable to harassment by man's activities (Miller and Gunn 1979b). Unfortunately, no knowledge of those areas exists for the High Arctic Islands and documentation is still fragmentary for the southern tier of islands; thus, evaluations of these habitats are lacking or incomplete. The surveys of the western Queen Elizabeth Islands during 1972-74 were flown in July and August, too late to identify calving areas (Miller *et al.* 1977a), but the Dundas Peninsula (southeast Melville Island) was identified as an important postcalving area (Miller *et al.* 1977a). Urquhart (1973) identified possible calving areas for arctic-island caribou on Banks Island in 1971. The most important was Ballast Beach on the northwest side of the island, but cows also calved in many other areas of the northern half of the island (Urquhart 1973). On Somerset Island, the Inuit believe Aston Bay is an important calving area, but Miller and Gunn (1979a) suggest that calving takes place south of Aston Bay. It also appears that the north and northwest coastal areas of Prince of Wales may be alternate calving areas to the west coast of Somerset (Miller and Gunn 1979a). On the Boothia Peninsula, caribou have calved south of Wrottesley Inlet south to Pasley Bay (Gunn and Ashevak, in prep.). On Victoria Island caribou calve north of Minto Inlet and south of Prince Albert Sound (A. Gunn, pers. commun.).

E2. Trend In Quantity Of Critical Habitat

In ungulate management, winter range is usually regarded as controlling the upper limits of a population. In the High Arctic, summer range may be as critical as winter range because the growing season is so short for the caribou to build up fat reserves (cf. Thomas 1982). There is no evidence that either winter or summer habitats were limiting factors in the past in terms of absolute forage production (e.g., Miller *et al.* 1977a). Ranges on an island basis are difficult to evaluate as caribou move between or among islands (e.g., Miller *et al.* 1977b, 1982). The choice areas of available habitat are small in comparison with the total land mass of the Canadian Arctic Archipelago, and large-scale industrial exploratory and exploitation activities have the potential to reduce or prevent access to or use of habitats (cf. Cameron *et al.* 1979, Cameron and Whitten 1980, Smith and Cameron 1983, Whitten and Cameron 1983).

Localized, potential habitat disturbance or destruction is possible from the use of tracked vehicles, spills of oil, fuel or drilling mud and the construction of roads and aircraft landing strips (e.g., Gunn *et al.* 1981, Gunn 1984). The presence of industrial installations and/or aircraft activities could result in harassment leading to caribou abandoning critical ranges (Miller and Gunn 1979b). It is

not only winter and summer habitats that are important habitats to Peary caribou, but also traditional calving, postcalving and rutting areas (cf. Gunn and Miller 1986). Any interference with caribou leading to a reduction in use of those important traditional areas as well as winter or summer ranges can be regarded as detrimental to the well-being of the Peary caribou and may impact at the population level (Fig. 3.).

Abandonment of ranges by Peary caribou due to industrial exploration activities has not been proven, but has already been implicated by Inuit hunters in declines of caribou on Bathurst Island (Freeman 1975, Miller *et al.* 1977a, Miller and Gunn 1978a). However, as emphasized by Miller *et al.* (1977a) and Miller and Gunn (1978a), natural factors such as weather also have to be examined before range abandonment can be correlated with industrial activity related disturbances.

E3. Protection Of Habitats

No areas containing Peary caribou habitats are specifically protected to date (Gunn *et al.* 1981). The Queen Elizabeth Islands Game Preserve was created in 1926, but it only prevented hunting by whites and provided no protection for Peary caribou habitats and was rescinded in 1966. The national park on Ellesmere Island and the park scheduled for Banks Island may afford some protection to habitats but will not prevent hunting. As noted by Gunn *et al.* (1981) the federal government or the Government of the Northwest Territories could recognize and legislate restrictions on land uses in sites identified by the International Biological Program, then some protection to habitats may be ensured but those identified sites are not important for Peary caribou.

The establishment in 1973 of a traditional hunting area for Inuit and limited restriction of human activities in May-July of each year on western Somerset Island gives limited protection to critical wintering areas and a likely calving area (Gunn *et al.* 1981). The limited restrictions were made possible under the Northwest Territories Land Act 1973.

E4. Degree of Specialization

If Peary caribou became extinct, no other ungulate could occupy its niche (Gunn *et al.* 1981). The High Arctic with its severe climate and low productivity of the vegetation imposes harsh and often subtle selective pressures, and mainland caribou could not survive without marked evolutionary modifications.

Although the evolution of Peary caribou has led to reasonably successful adaptations to the rigours of the Canadian High Arctic, it has at the same time apparently eliminated the ability of Peary caribou to compete successfully elsewhere with other forms of *Rangifer*. Possibly, genetic contamination of Peary

caribou with genes of barren-ground caribou has produced transitional forms of arctic-island caribou that apparently are better adapted to the environmental conditions of the southern tier of islands in the Canadian Arctic Archipelago than are either the *pearyi* from the High Arctic or *groenlandicus* from the mainland. Thus, the historic range of Peary caribou in Canada has already been reduced by more than half of its likely former size.

Even the Peary-like transitional form (possibly of *pearyi* > *groenlandicus*) now on the southern tier of Arctic Islands would not be successful over the long-term on the High Arctic Islands, without first evolving further toward *pearyi*. Physiologically and behaviourally there is only one form of *Rangifer* that can withstand the rigours of the Canadian High Arctic environment—the highly evolved Peary caribou that now occurs there.

There are in reality at least two genotypes of Canadian arctic-island caribou with three discernible phenotypic expressions: *pearyi*; *pearyi* > *groenlandicus*; and *groenlandicus* > *pearyi*. Biologically sound preservation and conservation efforts for Peary caribou, and indeed for all Canadian arctic-island caribou, can best be achieved by first recognizing these genetic and phenotypic distinctions. Most importantly only those caribou of the Queen Elizabeth Islands should be recognized as Peary caribou (all other caribou of the mid-arctic islands of the Canadian Arctic Archipelago should be considered separately as a distinct genotype of *Rangifer*).

F. General Biology

F1. Production And Recruitment

There is some evidence from sightings of newborn calves, that at least on Prince of Wales and Somerset islands, calving among some arctic-island caribou occurs in the third week of June (Miller *et al.* 1982). On Banks Island, calving took place during the first 2 weeks of June in 1971 (Urquhart 1973). Satellite-collared cows calved between 3 and 21 June on Victoria Island in 1987 and 1988 (A. Gunn, pers. commun.). In 1977, most caribou calved in the third week of June on the wet coastal area of Somerset Island but in 1978, after an exceptionally long and severe winter, calving was delayed until the fourth week of June and the cows travelled from Somerset to Prince of Wales Island to calve (Miller and Gunn 1979a). However, Fischer and Duncan (1976) reported cow-calf groups on Somerset and Prince of Wales islands between 15 and 22 June. Thus, those observations seemingly suggest that the timing and location of calving might be influenced indirectly by the severity and duration of the preceding winter (Gunn *et al.* 1981).

The proportion of bred yearlings on islands such as Somerset and Prince of Wales varied between and among years and apparently reflects their physical condition (Thomas and Broughton 1978, Thomas 1982). Cows between 2 years and about 10-13 years of age potentially can produce a single calf each year, but this potential is probably rarely realized because of failures to build-up sufficient fat reserves every year (Thomas 1982). Also, in many years when calves are produced they are not successfully reared or they die during the first winter of life (e.g., Miller *et al.* 1977a).

On Prince of Wales and Somerset islands, pregnancy rates were recorded from arctic-island caribou collected in 1974 through 1977 (Parker *et al.* 1975, Thomas *et al.* 1976, 1977, Thomas and Broughton 1978, Thomas 1982). The rates were 40% in 1974, 73% in 1976, 91.7% in 1975 and 100% in 1977. On the western Queen Elizabeth Islands pregnancy rates for Peary caribou in 1974-76 varied from 5.5-7.1% on Prince Patrick and Melville islands after the particularly severe winter of 1973-74, but recovered to 88% in 1977 (Parker *et al.* 1975, Thomas *et al.* 1976, 1977, Thomas and Broughton 1978, Thomas 1982). Those pregnancy rates were closely paralleled by the levels of fat reserves— low fat reserves were not observed in pregnant cows (Thomas 1982). The failure to breed is likely the result of insufficient replenishment of fat reserves during the summer after some winters (Thomas 1982). Unfortunately, there are no data on fat reserves in September-November, at or about the time of the rut (Thomas 1982). It is not known if the low pregnancy rates on Melville and Prince Patrick islands in 1975 and 1976 resulted from 1974-75 and 1975-76 winters being unfavourable, or if it

took 2 years to regain physical condition after the severe winter of 1973-74 to reinstitute normal levels of breeding and/or conception again in 1977 (Gunn *et al.* 1981).

Comparable data on pregnancy rates and calf and yearling counts exist only for arctic-island caribou during 1976 and 1977 on Prince of Wales Island (Miller and Gunn 1978a, 1978b). Unfortunately, the calf and yearling counts were spread over late June to August and possibly include overlap of counts. In March 1976, 73% of cows collected on Prince of Wales and Somerset islands were pregnant (Thomas *et al.* 1977). In July-August 1976, only 31.2% of the individuals classified as adult cows were accompanied by calves, and calves and yearlings represented 15.9% and 2.2%, respectively, among 1654 caribou segregated on northern Prince of Wales Island (Miller and Gunn 1978b). The following year, all of the nine cows collected on Somerset and Prince of Wales islands were pregnant (Thomas and Broughton 1978). In June-August 1977, the percentage of cows accompanied by calves was considerably higher (85.1%) than in 1976; the percentage of calves of the 294 caribou segregated was 25.2% and the yearling percentage was 3.7% (Miller and Gunn 1978b). The springs of 1976 and 1977 were late and normal, respectively (Miller and Gunn, unpubl. data), though snow conditions in March were similar during both years. The extremely low recruitment of yearlings emphasizes the vulnerability of that age class, and also, in the long-term, the population to any additional mortality.

The percentage of calves in the arctic-island caribou population on Banks Island had remained relatively high and stable from 1970 to 1973. The apparent increase from 19.1% in June 1970 (Kevan 1974) to 27.9% in June 1971 (Urquhart 1973) was probably due to the greater proportion of cows in the population resulting from differential winter mortality during the severe winter of 1970-71 as bulls and short yearlings were more vulnerable than cows (Urquhart 1973). In July 1972, Boukhout (in Urquhart 1973) segregated 23.9% calves and Wilkinson *et al.* (1976) estimated 20.0 % calves in July-August 1973 on Banks Island. The high percentages of calves on Banks Island probably reflects both the relative luxuriant tundra vegetation found there (Banfield 1961) and relatively favourable weather conditions during some years.

During the same period on the western Queen Elizabeth Islands, the Peary caribou calf crops were lacking or the percentages of calves were markedly lower and varied between and among years and islands (Miller *et al.* 1977a). In 1972, there were no calves seen in July-August on Melville Island, but in 1973, 17.7% of the segregated caribou were calves. Few or none survived the catastrophic winter of 1973-74. The percentage of calves dropped to 1.1% in 1974. On Prince Patrick Island, calves were 10.7% and 7.0% of the segregated caribou in 1973 and 1974, respectively. The calf crops on the Queen Elizabeth Islands in 1961 were

comparable to those in the early seventies on Banks Island. Tener (1963) found 19.0% and 20.3% calves on Melville and Prince Patrick islands, respectively, in July 1961.

The survival of calves during their first year of life, especially their first winter is usually poor (Gunn *et al.* 1981). The published highest short yearling count for arctic-island caribou is 11.4% in March 1971 on Banks Island after an apparently severe winter (Urquhart 1973). However, for Peary caribou in June-July 1961 Tener (1963) recorded 3.5% yearlings on Bathurst Island, 4.3% on Melville Island and 5.8% on Prince Patrick Island. Miller *et al.* (1977a) abandoned their attempts to segregate short yearlings of Peary caribou during March-April aerial surveys of the western Queen Elizabeth Islands because they were not seeing any short yearlings. They suggested that few, if any, calves survived during 1973-74 to the age of short yearlings. The 1972-75 annual recruitment rates of Peary caribou on the western Queen Elizabeth Islands were negligible (Gunn *et al.* 1981). The lack of recruitment is reflected in the age structure of the population on Melville and Prince Patrick islands: the 20 caribou collected on those islands in 1977 were all aged 7 years or older, the average was 9.9 years and range 7-13 years (Thomas and Broughton 1978).

In contrast to the Peary caribou on the western Queen Elizabeth Islands, the arctic-island caribou on Prince of Wales and Somerset islands were a younger-aged population (average age 4 years, range 1-11 years) with consistently higher productivity (Thomas 1982). Again, the differences between the caribou populations on the islands north and south of Viscount Melville Sound, Barrow Strait and Lancaster Sound likely reflect relative differences in forage quantity, quality and availability and different long-term weather conditions between the two regions (Gunn *et al.* 1981).

The maximum life-span of Peary caribou is about 15 years (Gunn *et al.* 1981). The greatest cause of mortality apparently is extreme malnutrition caused by widespread forage unavailability due to unfavourable snow or ice conditions (Parker *et al.* 1975, Miller *et al.* 1977a, Gunn *et al.* 1981). Carcasses of winter-killed caribou with symptoms of malnutrition were found after the 1970-71 and 1977-78 severe winters on Banks Island (Urquhart 1973, Morrison 1978) and on Bathurst Island and eastern Melville Island after the extremely severe winter of 1973-74 (Parker *et al.* 1975). Adult male caribou, yearlings and calves were the most vulnerable classes to mortality caused by malnutrition. The rutting activities of adult males deplete their fat deposits before the beginning of winter, thus their body reserves are often lacking and usually lower than those of females in late winter (e.g., Thomas *et al.* 1976, 1977, Thomas and Broughton 1978, Thomas 1982).

F2. Species Movements

Peary caribou and other arctic-island caribou, like many other cervids, make regular migrations between winter and summer ranges and calving and rutting areas. The unique characteristic of migrations by Peary caribou is that both inter-island and intra-island movements are involved (Miller *et al.* 1977b, Miller and Gunn 1978a, 1979a, 1980, Miller and Kiliaan 1980a, 1981, Miller, in press). There are data on two inter-island complexes: one involving the western Queen Elizabeth Islands of Melville-Eglinton-Prince Patrick; and the other Prince of Wales and Somerset islands and the northern Boothia Peninsula. Those inter-island or island-peninsula migrations may have originated through responses to environmental stresses caused by expanding populations, or winter forage unavailability and the migrations are perpetuated by tradition (e.g., Miller *et al.* 1977a, 1977b; Miller, in press).

Sightings of aerially dye-sprayed caribou on Prince Patrick, Eglinton and Melville in June 1974 that had been dye-sprayed on Prince Patrick and Eglinton in April 1974 and the observation of caribou on the sea-ice confirmed inter-island movements of many individuals within that island-complex. Earlier, detected differences in numbers of caribou seen during aerial surveys of those islands (Miller *et al.* 1977a, 1977b) had led to the belief that Peary caribou were migrating between winter ranges on Prince Patrick and Eglinton and summer ranges on Melville Island.

The Inuit of Resolute Bay and Spence Bay had knowledge of the crossing of Peel Sound by arctic-island caribou wintering on Somerset Island and summering on Prince of Wales Island (Gunn *et al.* 1981). These migrations during May-July were subsequently confirmed and quantified from 1977 to 1980 (Miller and Gunn 1978a, 1979a, 1980, Miller and Kiliaan 1980a, 1981).

Intra-island movements by Peary caribou between winter and summer ranges and to calving or rutting areas are characteristic on many, if not all, islands (Miller, in press). Caribou on Banks Island move north from wintering ranges on the west coast to the northwest and north coast in May (Urquhart 1973). Peary caribou move to coastal areas on northwestern Melville Island, southeastern Melville (the Dundas Peninsula) and eastern Melville at or shortly after calving (Miller *et al.* 1977a, Miller 1988). As the thaw advances in the interior during postcalving, the caribou move inland to higher interior plateaus (Miller *et al.* 1977a). By mid to late August on into September, caribou likely make pre-rut movements back to the coast where the rutting occurs (Miller *et al.* 1977a), based on the relatively high numbers of large male antlers cast on coastal sites.

The cycle of annual movements of Peary caribou is similar to the annual cycle of movements of barren-ground caribou, although there are some different envi-

ronmental factors involved (Miller 1982). For example, Peary caribou are rarely, if ever, harassed by biting insects which cause some of the mid-summer movements of barren-ground caribou.

The existence of inter- and intra-island movements increases the vulnerability of Peary caribou to disturbance by man's activities (Gunn *et al.* 1981). As the Peary caribou has such a short season in which to build-up fat reserves, any disturbance of its movements tied to the phenology of or the relative availability of the vegetation could have serious consequences. Interruptions and/or disruptions of movements to areas critical during gestation could disrupt or prevent reproduction. Finally, inter-island movements are vitally necessary for restocking islands after declines. Also, although long-term benefits of mixing gene pools within each genotype are difficult to evaluate, such mixing is theoretically beneficial, if not essential, for the well-being of the genome. Continued separation of genotypes (Peary caribou vs. arctic-island caribou) remains paramount, however, from a genetical standpoint in the maintenance and further evolution of Peary caribou.

F3. Behaviour/Adaptability

Peary caribou are usually found in small groups during winter (e.g. Miller *et al.* 1977a). The groups slightly increase in size prior to calving, stabilize or slightly decrease during calving, then increase into postcalving aggregations as the caribou leave coastal sites and move inland in late July and early August (e.g., Tener 1961, Miller *et al.* 1977a, Miller 1987a, 1987b, 1988). There was some consistency between mean group sizes of winter and summer 1972-74, despite the reduction in numbers of caribou especially in the winter 1973-74 (Miller *et al.* 1977a). Miller *et al.* (1977a) suggested that the winter group (mean of 3-5 caribou) is probably a closed social unit consisting of a family gathering or of sex and/or age related companion animals. Those social units aggregate in July-August to form groupings that average 10.1 (2-77) in 1972, 8.6 (2-60) in 1973 and 7.2 (2-33) in 1974 on Melville Island (Miller *et al.* 1977a). Subsequently, lower densities on Melville Island have led to smaller postcalving groupings of Peary caribou: e.g., mean 5.5 ± 0.27 (S.E.), range 2-20, $n = 165$, in July 1987 (Miller 1988).

The feeding habits of Peary caribou and arctic-island caribou are relatively nonspecialized and they mainly forage on sedges, grasses, willow and forbs (Thomas *et al.* 1976, 1977, Parker 1978, Shank *et al.* 1978, Thomas and Broughton 1978, Thomas and Edmonds 1983). In contrast to most barren-ground caribou diets, lichens are usually of low proportion in the rumens of Peary and arctic-island caribou, which apparently reflects the low standing crops of lichen (e.g., Russell *et al.* 1978, Thomas and Edmonds 1983). The volume of mosses in the winter diet (based on rumen contents) is usually high in Peary caribou in poor

physical condition (Parker *et al.* 1975, Thomas *et al.* 1976, 1977, Thomas and Broughton 1978, Thomas and Edmonds 1983). The high volume of mosses has been related to accidental ingestion because of high indigestibility of mosses (Parker *et al.* 1975, Thomas and Edmonds 1983), but it is also possible that mosses help to maintain the necessary minimum bulk for effective rumen function (Thomas and Kroeger 1980).

In winter, Peary caribou forage on hilltops, windswept ridges, or raised beaches, which have shallow snow cover or are blown free of snow. Caribou will also use broken rock and boulder fields where snow is deeper but soft or loose and not crusted by the wind. When temperatures in the snow cover climb above 0°C, melt water percolates down through the snow and refreezes at the snow cover-ground surface interface (Miller *et al.* 1982). Wherever the snow cover is 30 cm or more, a significant depth of ground fast ice can accumulate. Such ice layering of several or more centimetres can effectively make much or all of the ground vegetation on such sites unavailable to caribou (Miller *et al.* 1982). Caribou must respond by leaving rock and boulder fields and other iced areas and move to forage on snow free patches of ground, which is also where plant green-up occurs first (Miller and Gunn 1979a, Miller and Kiliaan 1980b, Miller *et al.* 1982).

With the loss of the snow cover caribou feed selectively following the phenology of the vegetation (Gunn *et al.* 1981). They favour the flowers of *Saxifraga oppositifolia*, *Papaver radiculatum* and *Pedicularis* spp. which are high energy and protein (pre-anthesis flower stage) sources (e.g., Miller *et al.* 1982, Thomas and Edmonds 1984).

Specific adaptations of Peary caribou to their harsh environment are not detailed except for morphological ones: e.g. their small size and proportions of their appendages, the thick predominantly whitish winter pelage and their relatively large hooves. Their small groups may be a compromise between social affinities and maintenance of traditions and the sparseness of their forage (Gunn *et al.* 1981). The virtual absence of bloodsucking and biting insects undoubtedly aids in the depositing of high fat reserves (e.g., the 55 mm of back fat on bulls collected on Prince of Wales Island in August 1978) (D.C. Thomas, unpubl. data). Little is known about their physiology (Gunn *et al.* 1981), though small amounts of lichen in the winter diet solicit interesting questions about urea recycling, water turnover et cetera compared with barren-ground caribou, woodland caribou (*R. t. caribou*) and reindeer (*R. t. tarandus*).

Little is known about the rut, gestation, parturition, or the mother-young bond in Peary caribou. However, those behaviours along with agonistic and escape behaviours seemingly parallel those exhibited by barren-ground caribou (Miller 1982).

Whether or not Peary caribou can adapt to man-made changes in their environment remains a critical question (Gunn *et al.* 1981). Seismic lines were avoided or paralleled by arctic-island caribou on Banks Island (Urquhart 1973). On Prince of Wales Island caribou cows and calves were more responsive to helicopter harassment, either overflights or landings nearby, than other sex/age classes (Miller and Gunn 1979b, 1981, 1982, Gunn and Miller 1980, Gunn 1984). Conditions that could lead to habituation of Peary caribou to aircraft, ground vehicles, people or installations remain unknown (Miller and Gunn 1979b).

G. Limiting Factors

The foremost limitation to Peary caribou is widespread wintertime forage unavailability due to unfavourable snow cover and ice conditions (Gunn *et al.* 1981). Springtime ground fast ice or even autumn icing can bond the vegetation to the ground: the reduced vertical development of many arctic plants and the absence of thick mats of lichens result in even a thin layer of ice preventing foraging. Wind-packed snow, especially snow deeper than 30 cm, prevents cratering or increases the energy required to crater forcing the caribou to move to seek snow-free or shallow snow foraging areas (Miller *et al.* 1982). Such movements can result in the caribou leaving an island routinely or in a desperate search for areas to forage in (McEwan 1955, Manning and Macpherson 1958, Urquhart 1973, Miller and Gunn 1978a, 1979a Miller *et al.* 1982). Mortality from extreme malnutrition, poor recruitment rates and low productivity are the limitations imposed on the growth of Peary caribou populations by winter snow and ice conditions. Whether these unfavourable climatic conditions from at least the 1960s into the 1980s have occurred naturally over time or have in some way been aggravated or produced by man's actions remains unknown. Unfortunately, weather records for the Canadian Arctic Archipelago are extremely limited, being often fragmentary and spanning less than the last 40-50 years. The network of government weather stations has always been small and sparsely scattered throughout the arctic archipelago. Thus, existing weather data for the Canadian Arctic Islands do not readily lend themselves to interpretation regarding ecological relationships, and any possible changes or the causes for those changes in the climate's pernicious impact on Peary caribou during the last three decades.

The separation of the genotypes strongly suggests that winter weather is a more stringent limiting factor on Peary caribou on the Queen Elizabeth Islands than on arctic-island caribou on the mid-arctic islands. The vegetation on the mid-arctic islands is more productive than on the High Arctic Islands (Bliss 1978), but the significance of this to caribou population changes cannot be evaluated in the absence of knowledge of possible relative availabilities of forage between those two regions. Certainly in summer 1961 the Queen Elizabeth Islands held a large caribou population (Tener 1963), but the climatic records support the contention that the decline since 1961 is due mainly to above average severity in winters rather than to the numbers of caribou exceeding the capacity of the ranges (Gunn *et al.* 1981).

Peary caribou in the Canadian High Arctic have declined drastically in number during the last three decades to a mere remnant of their former population size. This extreme reduction in the overall number of Peary caribou follows directly on the era of surface testing of "dirty" atomic bombs. Thus, current consideration of the status of Peary caribou parallels the period of ever increasing

scientific recognition and general public awareness of the current and potential magnitude and seriousness of circumpolar atmospheric fallout, global anthropogenic climate change and man's insidious pollution of the arctic environment. Therefore it is reasonable to consider the possibility that man by subtly influencing the environmental conditions of the Arctic has been partially, at least, indirectly responsible for the recent decline in the world's population of Peary caribou. Antagonists will state that there are no data to support this supposition about man's role in indirectly causing declines in ungulate populations. Advocates can, however, counter that the lack of evidence to the contrary does not in itself refute any supposition about man's actions possibly having played an indirect role in this recent decline of Peary caribou. Man-induced pollutants in the atmosphere could have already initiated subtle changes in the pattern of arctic weather over the past few decades and the involvement of man in causing those changes has simply as yet been indiscernible. Such man-caused changes could have influenced and altered the timing, degree, and combination of weather elements in ways that led to critically higher than previously naturally occurring rates of unfavourable change in weather conditions from the late 1950s to present. Those accumulated anthropogenic changes in weather conditions could have indirectly precipitated the observed catastrophic loss of Peary caribou through exceptionally high levels of mortality among all age and sex classes and frequent failures of calf crops or severe mortality among newborn calves. The apparent proximal cause, extreme malnutrition due to widespread wintertime forage unavailability brought on by the then prevailing snow and ice conditions, could mistakenly be judged as solely naturally occurring events. Thus, it is not necessarily logical or desirable at this time to completely absolve man from any responsibility in this ecological disaster. This position is especially apt, as there is no indication whatsoever that man's mistreatment of his environment will be corrected before environmental conditions worsen markedly worldwide and, probably, most severely in arctic regions. The Arctic is where environmental scientists believe anthropogenic atmospheric pollution will have its greatest impact on climate. The Arctic is also where environmental scientists have already found exceptionally high, unnaturally occurring levels of various toxins in marine and terrestrial ecosystems. Thus, man's unwitting past, present, and likely greater future contributions to circumpolar atmospheric fallout and contamination of the arctic environment cannot be discounted at this time as a possible cause or contributing factor in the seemingly only recent inability of Peary caribou to cope over time with environmental conditions in the Canadian High Arctic.

The impact of arctic wolf (*Canis lupus arctos*) predation on Peary caribou is unknown (Gunn *et al.* 1981). Wolves are not numerous on the western Queen Elizabeth Islands (Miller 1978, Miller and Russell 1978), but they are almost totally dependent on Peary caribou and muskoxen for much of the year. An im-

portant consideration involving wolf predation on Peary caribou is the possible indirect influence of the highs in populations of muskoxen and caribou on the same areas being out of synchronization. For example, currently on Melville Island the muskox population is increasing rapidly in size while the Peary caribou population continues its long-term decline. The wolves on Melville will likely increase in number in response to the greater numbers of muskoxen. Therefore, even only incidental predation by wolves on the Peary caribou on Melville Island could become significant on a proportionate basis. This condition would be particularly important, if selective predation on newborn caribou also routinely occurs as wolf numbers increase (cf. Miller *et al.* 1985). Thus, the relative importance of wolf predation on Peary caribou likely varies greatly over time and space and cannot be totally dismissed as it is most likely an intermittent serious cause of mortality.

Many Inuit believe that competition occurs between muskoxen and Peary caribou or arctic-island caribou and that it often leads to drastic reductions in the numbers of caribou. To date, however, investigations of this supposed muskox-caribou competition have yielded no proof that competition for space or forage exists: Kevan (1974), Wilkinson *et al.* (1976), Parker and Ross (1976), Miller *et al.* (1977a), Parker (1978), Vincent and Gunn (1981), and Thomas and Edmonds (1984). If such competition ever does occur at all, it most likely would occur during wintertime or springtime periods of widespread forage unavailability brought on by unfavourable snow cover or icing conditions (Miller *et al.* 1977a). Such conditions were observed on Bathurst Island in late winter 1973-74 (Miller *et al.* 1977a) but no competition between the muskoxen and caribou was discerned.

Evidence of debilitating diseases was not found in Peary caribou or other arctic-island caribou necropsied by Parker *et al.* (1975), Thomas *et al.* (1976, 1977), and Thomas and Broughton (1978). Those authors also reported a low but variable incidence of warble fly (*Oedemagena tarandi* L.) larvae between and among island and year.

Peary caribou are traditionally hunted in early and late winter, though use of snowmobiles has tended to lengthen the Inuit's hunting season (e.g., Bissett 1968, Riewe 1973). Changes in the Inuit hunting patterns have resulted from the shift to a wage earning economy (Riewe 1978). Inuit can now often improve their hunting effectiveness by purchasing better equipment and more supplies. This has probably more recently increased the pressure on arctic-island caribou, as it already did in the 1960s on Peary caribou on southern Ellesmere Island (Riewe 1973).

As noted by Gunn *et al.* (1981), Inuit of Grise Fiord annually took an average of 26 Peary caribou in the Jones Sound region but "even this minuscule harvest

has had deleterious effects upon the caribou population" (Riewe 1973:21) and, "By 1968 the caribou were virtually eliminated" (Riewe 1973:22) within 60 km of Grise Fiord. The southern Ellsemere population of caribou might already have been in a state of decline due to climatic changes (cf. Vibe 1967, Riewe 1973), but there is little doubt that hunting was an additional decimator of the caribou that accelerated or even caused the decline. More recently the annual harvest of Peary caribou by Grise Fiord Inuit has dropped from about 50 in the early 1980s to 25 in 1986 and 1987 (M. A. D. Ferguson, pers. commun.). On the other Queen Elizabeth Islands, there was some industry-supported hunting out of Rae Point on eastern Melville Island during the 1970s (Gunn *et al.* 1981). Caribou hunting on Bathurst Island was voluntarily stopped by the Resolute Bay Inuit hunters in 1975, when the caribou numbers became dangerously low (Freeman 1975). Since 1975 most and since 1982 all of the caribou killed by Resolute Bay hunters come from Somerset, Prince of Wales and Russell islands. Currently, some of those harvested caribou are sold to the Grise Fiord Inuit.

Caribou meat is highly valued by the Inuit and little is wasted (Usher 1970, Riewe 1978). Although hunting techniques have changed (as have storage facilities) and the duration of the annual caribou hunting period has been extended (Bissett 1968, Usher 1970, Riewe 1973, 1978), there is no general acceptance within the Inuit communities that hunting has the potential for becoming one of or especially the major limiting factor for caribou (Gunn *et al.* 1981).

Severe limitations imposed by climate on populations of arctic-island caribou, especially Peary caribou on the High Arctic Islands, can magnify other factors affecting population levels and increase the possibility of these becoming greater limiting factors (Fig. 3). In particular, the effects of even apparently low levels of incidental wolf predation or intensive harassment by aircraft, ground vehicles or ground installations could have an insidious effect on Peary caribou, that in time, could be a limiting factor (e.g., Miller and Gunn 1979b, Gunn 1984). Interruption of foraging patterns during the short summer could reduce the fat reserves needed for successful reproduction, and similarly, any increased energy expenditure as a response of harassment could have long-term effects on reproduction, as well as survival (Fig. 3). The importance of traditional areas and seasonal ranges to the survival of Peary caribou has been previously noted (Gunn *et al.* 1981). In the absence of data to the contrary, it was suggested that any harassment reducing or preventing free movements among those areas, would act as a limiting factor on subsequent population growth and survival.

The effects of harvest, predation and harassment have to be considered in light of the low recruitment, which is apparently characteristic of the Peary caribou, and the often high mortality (Gunn *et al.* 1981). In such a situation, where

the caribou populations are so strongly controlled by climate, any additional factors can tilt the balance to the detriment of the caribou populations.

H. Special Significance of the Species

The Peary caribou is a unique, socially important and economically valuable part of Canada's natural heritage. The Peary caribou is now regularly found nowhere in the world outside of the Canadian High Arctic; thus, the responsibility for its preservation is totally Canadian.

The Peary caribou has the most restricted distribution in terms of usable range of the North American caribou as they occur regularly only on the High Arctic Islands of Canada. The arctic-island caribou have only a slightly larger usable range (but generally of better quality), occurring on the mid-arctic islands in the southern tier of the Canadian Arctic Archipelago and on the Boothia Peninsula of the mainland Northwest Territories. Unfortunately, the arctic-island caribou have never received the special recognition that they deserve as a discrete form of *Rangifer*. Remoteness and isolation of the Peary caribou's range is generally reflected in our lack of knowledge about the subspecies (Jakimchuk 1975). Although Peary caribou were known and utilized by early explorers of the High Arctic Islands (e.g., Miller *et al.* 1977a), they were not recognized as a distinct form until Allen (1908) described them from specimens collected by R. E. Peary on Ellesmere Island. The current taxonomic status of Peary caribou is as a subspecies (Banfield 1961). Interbreeding with *R. t. groenlandicus* may have contributed to the differentiation of the arctic-island caribou that occur on all of the southern tier of islands in the archipelago (Manning 1960, Banfield 1961, Thomas and Everson 1982, Røed *et al.* 1986). The most characteristic and genetically purest stock of *pearyi* now occurs only on the Queen Elizabeth Islands.

R. t. pearyi is distinguished from other subspecies by its small size, short and blunt but proportionately large hooves and a short pointed muzzle. One of the most characteristic features is the silky long predominantly whitish winter coat. The antlers have pale gray velvet in summer, and the pelage is slate-coloured above with white legs and undersides in summer (Manning 1960, Banfield 1961).

The Peary caribou was possibly an important source of food for the early natives on Ellesmere and other islands (Riewe 1973), and is still highly preferred meat by Inuit in the High Arctic. The early explorers to the Arctic Islands also eagerly hunted Peary caribou for fresh meat.

The population dynamics of Peary caribou apparently have been dominated by the recent climate, especially the stresses of wintertime conditions that strongly influence rates of reproduction, recruitment and adult survival (Gunn *et al.* 1981). The inter-island movements are a particularly significant adaptation to sparse ranges, unfavourable snow and ice conditions and the recolonization of islands, after severe winters periodically or sporadically depopulated the caribou (Miller, in press). There are likely few large mammal populations that show such marked highs and lows in their numbers almost entirely due to weather affecting

forage availability. However, the importance of wolf predation alone or in combination with unfavourable weather conditions during population highs and especially during population lows is unknown.

As noted by Gunn *et al.* (1981), the Peary caribou is an important prey item for the high arctic wolf and carrion for scavengers such as arctic foxes (*Alopex lagopus*), gulls (*Larus spp.*) and jaegers (*Stercorarius spp.*). Also, the Peary caribou is not only a source of meat for the Inuit, but it is a symbol of their cultural relationships with their environment. The adaptations and adaptability of Peary caribou make it a particularly intriguing form of *Rangifer* to biologists, and thus as an integral part of Canada's arctic ecosystem – the conservation of Peary caribou should be a matter of broad concern.

The Peary caribou of the Canadian High Arctic Islands is the only member of the deer family Cervidae that has been able to establish itself and persist there under present day climatic conditions. However, the current overall number of Peary caribou on those islands is dangerously low and a mere remnant of their former numbers. Thus, existing populations of Peary caribou are essentially unharvestable on a sustained yield basis.

Therefore, to reiterate, the Peary caribou warrants recognition as an endangered form of wildlife in Canada because (1) the total number of the genetically purest form is critically low (3300-3600); (2) it is the sole representative of the deer family Cervidae and of the caribou/reindeer genus *Rangifer* found in the Canadian High Arctic; (3) it is a unique part of Canada's natural heritage, as it now occurs regularly, on a worldwide basis only on the Queen Elizabeth Islands of the Canadian High Arctic; (4) it is economically valuable, both as a staple nourishment and for future tourism; (5) it is culturally important to the High Arctic Inuit, as a symbol of traditional ties to their environment; and (6) anthropogenic climate change ("The Greenhouse Effect"), greatly increased exploration for and development of nonrenewable resource activities, and increased hunting pressure all have the potential for impacting detrimentally on populations of Peary caribou in the Canadian High Arctic.

I. Recommendations/Management Options

In summary, the Peary caribou numbers on the Queen Elizabeth Islands are less than 10% of their former (1961) strength (except on the eastern islands of Ellesmere, Devon and Axel Heiberg where their numbers never were high). This low comes at a time when man-induced pressures on them could markedly increase, including changes in future climatic patterns that are brought on by man's actions—"The Greenhouse Effect". The seriousness of their low numbers is apparent from a projection of population increases possible in a favourable environment on southwestern and south-central Queen Elizabeth Islands (Table 5). The likelihood that favourable conditions would allow prolonged rapid increases in numbers of Peary caribou in the near future is, at best, most doubtful based on the past 26 years (1961-87) of information on population dynamics and the current low number of Peary caribou. Thus, several decades must pass before significant recovery of Peary caribou could occur in the Canadian High Arctic (Table 5). In the interim, the Inuit of the High Arctic need the moral support that will come from the realization that other Canadians recognize the potential dangers to Peary caribou caused by a changing world. Thus, recognition by the members of COSEWIC of the precarious and currently endangered existence of Peary caribou with toleration of the High Arctic Inuit's cultural and economic needs for at least limited harvesting of the resource would be a great stride forward in initiating the preservation of Peary caribou.

Exploration and exploitation of petroleum and mineral resources increased steadily throughout the 1970s in the Canadian Arctic. Then, a temporary lull set in as the demand on the world markets for crude oil and metals weakened and third-world countries cut prices. It is only a matter of time, however, before world markets improve and higher prices stimulate renewed vigour in nonrenewable resource exploitation in the Canadian Arctic. All-year ice-breakers and barges could represent a potentially serious effect on inter-island movements to escape environmental stresses and seasonal migrations to maximize the use of the best ranges available. Almost all developments will be accompanied by increases in aircraft traffic and ground installations. In addition, the employment of Inuit can indirectly increase hunting pressures because of increased cash to purchase hunting equipment and supplies. These changes on a large-scale have the potential for seriously impacting on Peary caribou (Fig. 3).

COSEWIC should thus consider the following. (1) The Peary caribou is culturally important and economically valuable (utilization and tourism) to the High Arctic Inuit. (2) The overall number of Peary caribou is dangerously low, at an estimated 3300-3600. (3) Man's activities potentially could further the observed long-term decline, keeping the number of Peary caribou at an unusable level. (4) None of the populations of Peary caribou is currently capable of

TABLE 5

Extrapolations of Peary caribou populations on two island-complexes of the Queen Elizabeth Islands from the most recent estimated levels to usable and theoretical maximum densities that could be expected under satisfactory range and environmental conditions

At mean density ^a of caribou per 100 km ⁻²	Size of complex (km ²)	Expected number of caribou at given density	Years of continual population growth required to achieve mean densities at net annual increases of				
			25%	20%	15%	10%	5%
<u>Southwestern (1985-87 est. 1288)</u>							
5	61 310	3066	4	5	7	9	18
10		6131	7	9	11	17	32
15		9197	9	11	13	21	41
20		12 262	11	13	17	24	47
<u>South-central(1985-87 est. 779)</u>							
5	26 620	1331	3	3	4	6	11
10		2662	6	7	9	13	26
15		3993	8	9	12	18	34
20		5324	9	11	14	21	40

^a The assumption is that these populations of Peary caribou would become borderline usable at 5 caribou · 100 km⁻²; would be significantly usable at 10 caribou · 100 km⁻²; have reached an ideal stocking level at 15 caribou · 100 km⁻²; and would be reaching a maximum level at 20 caribou · 100 km⁻² beyond which the capacity of their range to support them on a year-round basis would be taxed.

sustaining any appreciable level of annual harvest. (5) No other form of *Rangifer* (even the arctic-island caribou) could successfully replace the Peary caribou (*R. t. pearyi*) in the demanding setting of the Queen Elizabeth Islands without significant climatic change or first evolving over time the necessary adaptations of *pearyi*. (6) The overall range of the true Peary caribou (*R. t. pearyi*) is now restricted to the Queen Elizabeth Islands of the Canadian Arctic Archipelago, only a small fraction of its former extent, as viable populations of *R. t. pearyi* currently do not exist in Greenland and *R. t. pearyi* has been replaced on the southern tier of islands in the Canadian Arctic Archipelago by a genotypically and phenotypically different form of arctic-island *Rangifer*. Thus, the true Peary caribou (*R. t. pearyi*) is a genetically unique form of *Rangifer* that is now found only in Canada and is currently endangered by its extremely low number, and possi-

bly by anthropogenic climate change, man-caused disturbance and contamination of arctic ranges, and increased hunting pressure. Therefore, the Peary caribou is now a unique part of Canada's arctic natural heritage and the preservation/conservation of the Peary caribou is firstly the responsibility of Canadians.

The Canadian Wildlife Service recommends that COSEWIC proceed as follows regarding the status of Peary caribou.

1. COSEWIC should first recognize and classify the Peary caribou (*R. t. pearyi*) now found regularly only on the Queen Elizabeth Islands of the Canadian Arctic Archipelago as currently "Endangered" and a unique genotype of *Rangifer* (different from other caribou now found on the southern tier of islands in the Canadian Arctic Archipelago or the mainland of Canada).
2. COSEWIC should next recognize and classify "arctic-island" caribou (*R. t. groenlandicus* x *pearyi*) now found on Banks Island as currently "Endangered" and a unique genotype of *Rangifer* different from other caribou now found on the Queen Elizabeth Islands or the mainland of Canada (except possibly the northern Boothia Peninsula).
3. COSEWIC should then recognize and classify "arctic-island" caribou (*R. t. groenlandicus* x *pearyi*) now found on the remainder of the southern tier of Arctic Islands (excluding Baffin and Bylot islands) and the Boothia Peninsula north of its isthmus (north of 70°N) as currently "Threatened" and a unique genotype of *Rangifer* different from other caribou now found on the Queen Elizabeth Islands or elsewhere on the mainland of Canada.

J. Evaluation

Degerbøl (1957:47, 54) and Banfield (1961:65) concluded from their investigations that Peary caribou (*R. t. pearyi*) and the now extinct East Greenland reindeer (*R. t. eogroenlandicus*) were closely related. More recently Willemsen (1983) and Hakala *et al.* (1985) have remarked on the similarity among *pearyi*, *eogroenlandicus*, and the Svalbard reindeer (*R. t. platyrhynchus*); thus, indicating a close taxonomic affinity among all three forms of circumpolar arctic island caribou. Further support for this relationship has been put forth by Røed *et al.* (1986) with the finding that one of only two alleles that coded for transferrin in the Svalbard reindeer is held in common with *pearyi* (neither has been found in continental reindeer or caribou).

Thus, after the end of the last Ice Age, surviving primitive Peary caribou radiated out from their refugium or refugia and colonized or recolonized the entire Canadian Arctic Archipelago (apparently except Baffin and Bylot islands) and likely areas of Greenland and Spitzbergen. During at least the last dispersal of caribou in the Canadian Arctic Archipelago the southern tier of islands was occupied to varying degrees possibly by both the subspecific *pearyi* form and the *groenlandicus* form.

The barren-ground caribou intergraded with the resident Peary caribou and became the dominant southern island forms (*pearyi* > *groenlandicus* and *groenlandicus* > *pearyi*). For unknown reasons the barren-ground caribou was only successful in colonizing the extreme eastern portion of the Archipelago (Baffin and Bylot) on a year-round basis at the exclusion of Peary caribou. Elsewhere on the southern islands the barren-ground caribou is known only to be successful as a summer migrant. Year-round occupation of the southern islands favoured the merging of *pearyi* and *groenlandicus* features— thus, apparently creating a better adapted intergrade whose current taxonomic designation as "Peary" caribou is misleading in terms of its preservation and conservation.

Peary caribou on the Queen Elizabeth Islands exhibit the most developed and genetically diverse characteristics of the *pearyi* form (Manning 1960, Banfield 1961, Thomas and Everson 1982, Røed *et al.* 1986). Thus, the stage is set only on the Queen Elizabeth Islands of the Canadian High Arctic for the further evolution of the *pearyi* form through physiological and behavioural adaptations to their more demanding and less rewarding environment.

Since 1961, Peary caribou on the Queen Elizabeth Islands have declined by about 92% on the islands where 94% of the 25 845 Peary caribou were estimated in 1961. Since 1972, arctic-island caribou on Banks Island have declined in number by about 70% and current rates of annual harvest exceed any sustainable level for the population. On Victoria Island the true current numerical status of arctic-island caribou is unknown within meaningful management limits, as evi-

denced by the biologically impossible disparities between existing population estimates and their reported associated rates of annual harvests. Elsewhere on the southern tier of Arctic Islands the current numerical status of populations of arctic-island caribou are unknown because of the lack of updated population estimates. Documentation of the genetic variation between arctic-island caribou (*R. t. groenlandicus* x *pearyi*) on the southern tier of Arctic Islands and the purest line of *pearyi* the Peary caribou on the Queen Elizabeth Islands continues (Røed *et al.* 1986, Røed and Whitten 1986; K. H. Røed, pers. commun., 1989). Although the taxonomic position of the "arctic-island" caribou appears transitional to *groenlandicus* and *pearyi*, it should for the purpose of its preservation and conservation be treated as a unique form of *Rangifer* and different from *pearyi* of the Queen Elizabeth Islands. Maintenance of populations of "arctic-island" caribou that can sustain relatively high levels of annual harvest is also critical to the conservation of Peary caribou on the Queen Elizabeth Islands. If high arctic Inuit could not hunt caribou on the southern tier of Arctic Islands, they would have to turn to the already depleted populations of Peary caribou on the Queen Elizabeth Islands for much of their annual diet of fresh red meat. The monetary benefits of hunting caribou are very real and the need for hunting caribou is culturally strong: 100 kg of preferred caribou meat is currently worth about \$2,000 at Resolute Bay prices for much less desirable store bought beef. Significant and sometimes catastrophic climate-caused fluctuations in numbers of Peary caribou on the High Arctic Islands are known. Possibly less disastrous but apparently significant losses of other "arctic-island" caribou due to unfavorable weather conditions leading to widespread forage unavailability have also been suggested for the mid-arctic islands of the Canadian Arctic Archipelago. The role of man in these weather related events is unknown but the possible influence of man's actions in indirectly aggravating or producing these events cannot be ruled out at this time.

Against the all-pervading influence of the severe climate on Peary caribou the potential effects of anthropogenic climate change, increased hunting, and rapidly increasing industrial activity could menace the future of Peary caribou.

Recognition by COSEWIC of the "Endangered" state of Peary caribou in the Canadian High Arctic would strengthen the likelihood for conservation of Peary caribou by fostering the will for self-restraint among the high arctic Inuit. Such recognition would also greatly assist in future efforts for the preservation of Peary caribou in the eventual face of inevitable nonrenewable resource development in the Canadian Arctic, man-caused contamination of arctic environs, and man-induced climatic patterns.

The Canadian Wildlife Service recommends specific guidelines for COSEWIC's various levels of classification based on 1+ yr-old Peary caribou only

TABLE 6

Recommended upper limits of Peary caribou populations (based on 1+ yr-old caribou only) to serve as guidelines for various levels of preservation/conservation of Peary caribou on the Queen Elizabeth Islands, Canadian High Arctic

Queen Elizabeth Islands involved by island-complex	Upper limits of Peary caribou populations by preservation/conservation categories			
	Endangered ($<$)	Threatened ($<$)	Vulnerable ($<$)	Rare ($<$)
<u>Southwestern QEI</u>	3000 ^a	6000	9000	12 000
Melville, Prince Patrick, Eglinton, Byam Martin and Emerald	(5.0) ^b	(10.0)	(15.0)	(20.0)
<u>South-central QEI</u>	1300	2700	4000	5500
Bathurst, Cornwallis, Vanier, Cameron, Alexander, Massey and Little Cornwallis	(5.0)	(10.0)	(15.0)	(20.0)
<u>Northwestern QEI</u>	100	200	300	500
Mackenzie King, Borden and Brock	(1.0)	(2.0)	(3.0)	(4.0)
<u>North-central QEI</u>	200	500	700	1000
Ellef Ringnes, Amund Ringnes, Cornwall, Graham, Loughheed, Meighen, King Christian and North Kent	(1.0)	(2.0)	(3.0)	(4.0)
<u>Eastern QEI</u>	1400	2600	4000	6000
Ellesmere, Devon and Axel Heiberg	(0.5)	(1.0)	(1.5)	(2.0)
Entire 26 QEI listed above	6000	12 000	18 000	25 000
Overall mean density per 100 km ²	(1.5)	(3.0)	(4.5)	(6.0)

^a These values are read as follows, e.g., Southwestern QEI: Endangered = less than 3000; Threatened = less than 6000; Vulnerable = less than 9000; Rare = less than 12 000; and greater than 12 000 Peary caribou 1+ yr-old would result in delisting.

^b Approximate mean density of 1+ yr-old Peary caribou per 100 km² within that island-complex at the upper limit of the given level (category) of preservation/conservation.

for setting upper limits of classification for Peary caribou populations on the Queen Elizabeth Islands (Table 6). It is recommended that Peary caribou on the Queen Elizabeth Island be recognized as "Endangered" as long as the number of 1+ yr-old Peary caribou on the entire Queen Elizabeth Islands remains below 6000 individuals.

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